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REPAIRING STEEL FREIGHT CARS.

PITTSBURGH & LAKE ERIE RAILROAD—MCKEES ROCKS, PA.

The Pittsburgh & Lake Erie Railroad was one of the first to use steel freight cars extensively. Located in the heart of the Pittsburgh district and having a heavy traffic of coal and coke in one direction and iron ore in the other, in addition to the products of the manufacturing plants along its lines, it has been able to use steel freight cars to special advantage.

The methods of maintaining and repairing these cars are in marked contrast to those used on the Baltimore & Ohio Railroad, as described at length in our May, 1907, issue. It will be recalled that the heavy repairs on the Baltimore & Ohio, at Mt. Clare, were made in the open with very few special facilities and no overhead cranes, and that the painting of the cars was done by hand. At the McKees Rocks shops of the Pittsburgh & Lake Erie a large building with traveling cranes has been provided so that repairs may be carried on expeditiously and without interruption during inclement weather. This building is used for heavy repairs of both steel and wooden equipment, but eventually will be entirely devoted to steel car work. A number of special devices have been provided to facilitate work on the steel cars and a comparatively large stock of finished material is carried so that damaged parts may be replaced immediately, making it possible to get the cars back into service without delay. The costs of repairing and scraping badly damaged parts are compared and the least expensive course followed. A spraying machine is used for painting the cars, thus effecting a considerable saving in time, labor and material.

At the present time 54.7 per cent. of the total freight car equipment is of steel construction. This includes 4,174 twin hopper gondola cars, 3,216 hopper cars, 1,600 coke cars, 117 flat cars and 250 composite gondola cars with steel underframes. As with the Baltimore & Ohio, some of the first cars which were introduced, when the art of steel car design was in its infancy, proved defective in certain respects, but in all cases this was overcome by reinforcing the weak parts. The designs have gradually been perfected until to-day very little difficulty is experienced with the steel cars under normal conditions, and these conditions are especially severe when we consider the method of loading coal cars and of unloading them at the docks; the reloading of the cars with ore, which in most cases is carried directly over the hopper doors, and the carrying of pig iron and hot billets.

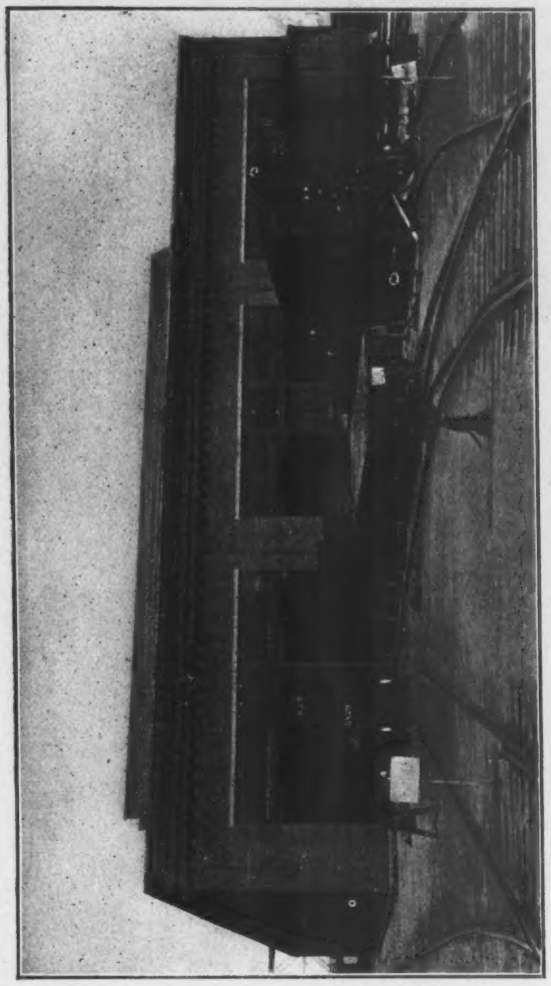
The car department repair plant lies just north of the locomotive repair shops, the general plan of which was considered on page 395 of our November, 1903, issue. The machine and erecting shops of the old locomotive repair plant were remodeled, after the new shops were built, and one is now used as a cab and tender shop and the other as a coach shop, as shown on the accompanying plan. The coaches, when ready for painting, are transferred to the paint shop at the western corner of the locomotive plant. The freight car repair department lies directly to the north of the coach shop. The freight car shop at present is 418 ft. 9½ in. long, but provision is made for its future extension to 654 ft. 7 in., as shown on the plan view of the building. It will accommodate 48 cars for heavy repairs, allowing 52 ft. to a car. There is room just north of the shop for 42 additional cars; north of the bridge extending over the tracks is a light repair yard, which will accommodate 100 cars, also a space which is devoted to the repainting of cars. Lying alongside of the light repair yard is a stock house at one end and a scrap platform at about the middle, where provision is made for removing coupler yokes and riveting them to new couplers, also for relining journal boxes. All old bolts and nuts are worked over on bolt threading and nut tapping machines and a post hammer and shears are provided for straightening and cutting them to length before re-threading them. A lumber storage shop and a woodworking shop are located alongside of the freight car shop and nearest to that part which is devoted to wooden car repairs. Material is delivered from one part of the plant to another over a system of standard gauge industrial tracks.

The car repair shop is of brick construction with steel framing and rests upon concrete foundations. The main portion of it is 418 ft. 9½ in. long by 154 ft. wide and is divided into three bays, each having two repair tracks, with a material track between. On the side of the shop devoted to steel car repairs is an extension, or additional bay, 23 ft. wide and 312 ft. 9½ in. long. Finished steel car parts are stored here and a furnace and machinery for repairing defective parts, or manufacturing new ones, also occupy part of this space. The construction of the building, together with the arrangement of the sawtooth roof, is shown in the accompanying drawings and photographs. The windows in the skylights are vertical and face toward the north, so that a plentiful supply of diffused light is admitted from above. In addition there is a large amount of window space in the side walls. Electric arc lights furnish artificial light. The building is heated with hot air by the Sturtevant system, the fans and heating apparatus being located in the extension of the building, as shown. The delivery pipes are carried overhead with downdrop outlets at proper intervals. Provision has been made to maintain a temperature of 50 degrees Fahr. during winter weather.

The two outer bays in the main part of the shop measure 53 ft. from the outside walls to the center of the row of columns, while the middle bay measures 48 ft. center to center of the columns. The repair tracks are spaced 24 ft. center to center and the two outer tracks measure 16 ft. from the inside of the wall to the center of the track. The underside of the roof trusses is 30 ft. from the floor. A 20-ton Shaw crane operates over the bay which is devoted to steel car repairs. The other two bays are used principally for heavy wooden car repairs, the middle bay being served by a 20-ton crane and the outer one by a 40-ton crane. The outer bay is used extensively for repairing loaded cars, and it is for this reason that the heavier crane is provided. The floor of the building, except for a small space near the furnace, which is of brick, is of 1⅞-in. plank laid on 4 x 4-in. sleepers spaced 30 in. center to center. These are laid on 6 inches of sand or gravel.

There are natural gas and compressed air connections at each column on either side of the bay used for steel car repairs. The natural gas is used in special burners for heating damaged parts without removing them from the car. Compressed air connections are provided at each column alongside of the bays for wooden car repairs.

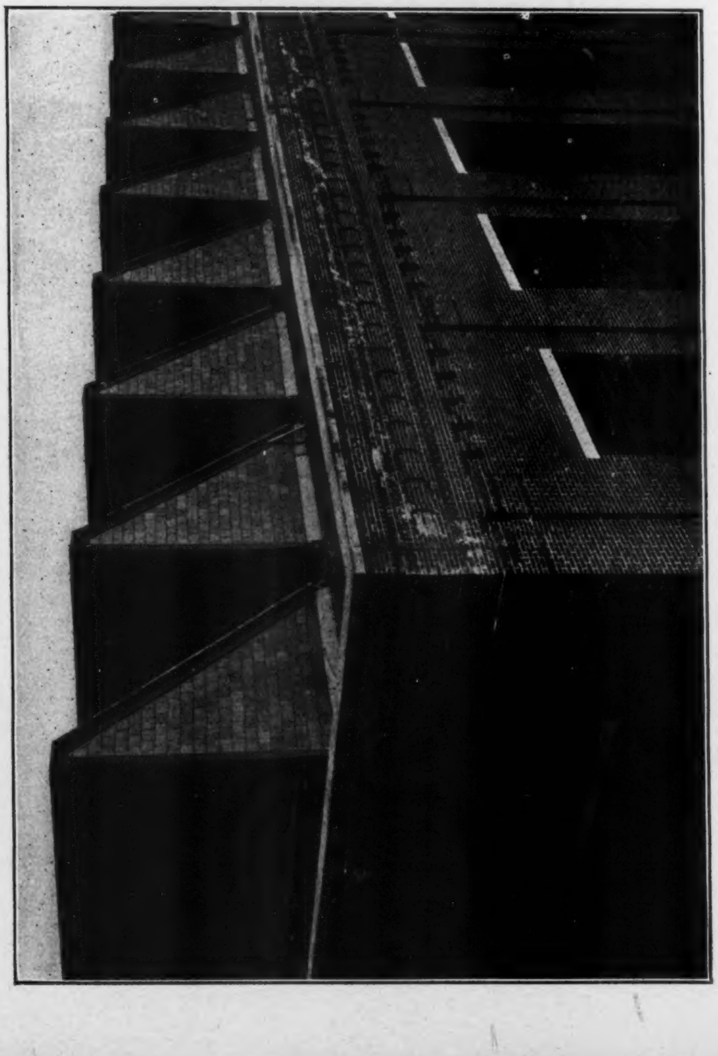
The apparatus used in connection with the steel car repair work, and located in the addition which practically forms a fourth bay and opens directly into the main part of the shop, consists of a furnace made by the Pittsburg Stoker Company, which uses fuel oil and has a capacity for 5,000 lbs. of steel parts. As has been stated, the distorted parts are cut off the cars and new ones from stock are applied. The damaged parts, if they are suitable for repair, are placed alongside the furnace and when a sufficient amount has accumulated they are piled inside, heated and repaired. At present it is only necessary to operate this furnace about two days of each week. A large open fire is provided for rush or emergency work. Just in front of the furnace is a large face plate on which plates or other parts may be straightened. The flanging clamp shown in one of the illustrations is operated by air and is provided with several dies and formers for straightening and manufacturing the larger parts such as draft sills, etc. An air press, which is used for bending the smaller pieces and is also equipped with a number of simple dies and formers for repairing old parts, or the manufacture of new ones, is also illustrated. A large drill press has been added which is not shown. Beyond the flanging clamp is an air oper-



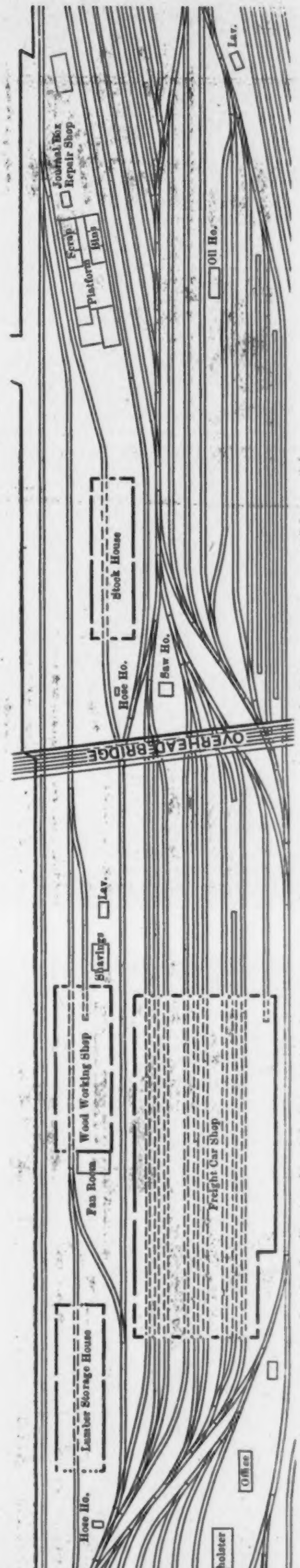
SOUTH END OF THE FREIGHT CAR REPAIR SHOP.

STORAGE SPACE FOR STEEL CAR REPAIR PARTS.

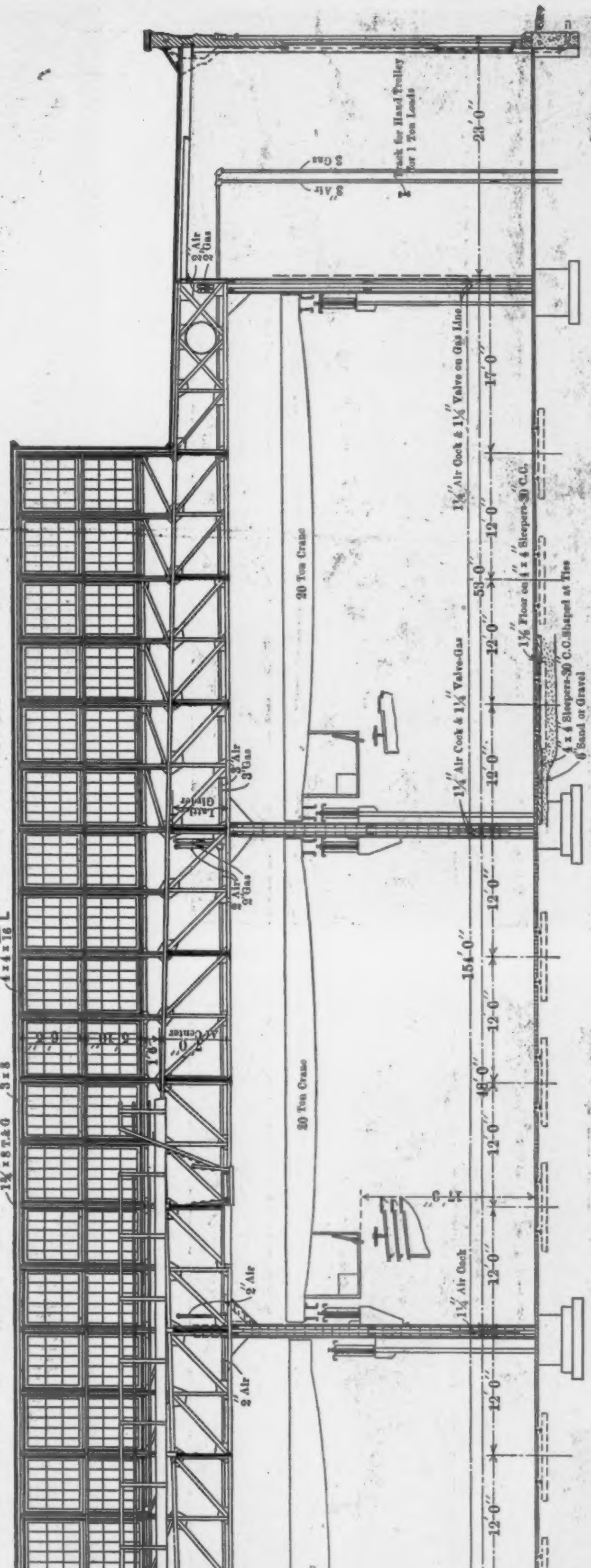
LOOKING DOWN THE MIDDLE BAY OF THE FREIGHT CAR REPAIR SHOP.



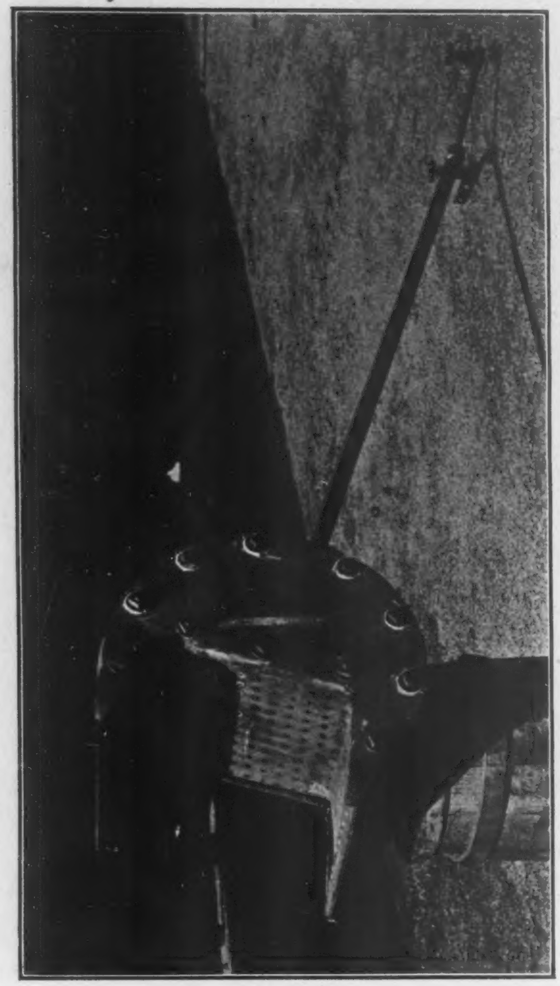
ROOF CONSTRUCTION OF THE FREIGHT CAR REPAIR SHOP.



GENERAL PLAN OF THE PITTSBURGH & LAKE ERIE RAILROAD CAR REPAIR DEPARTMENT, MCKEES ROCKS, PA.



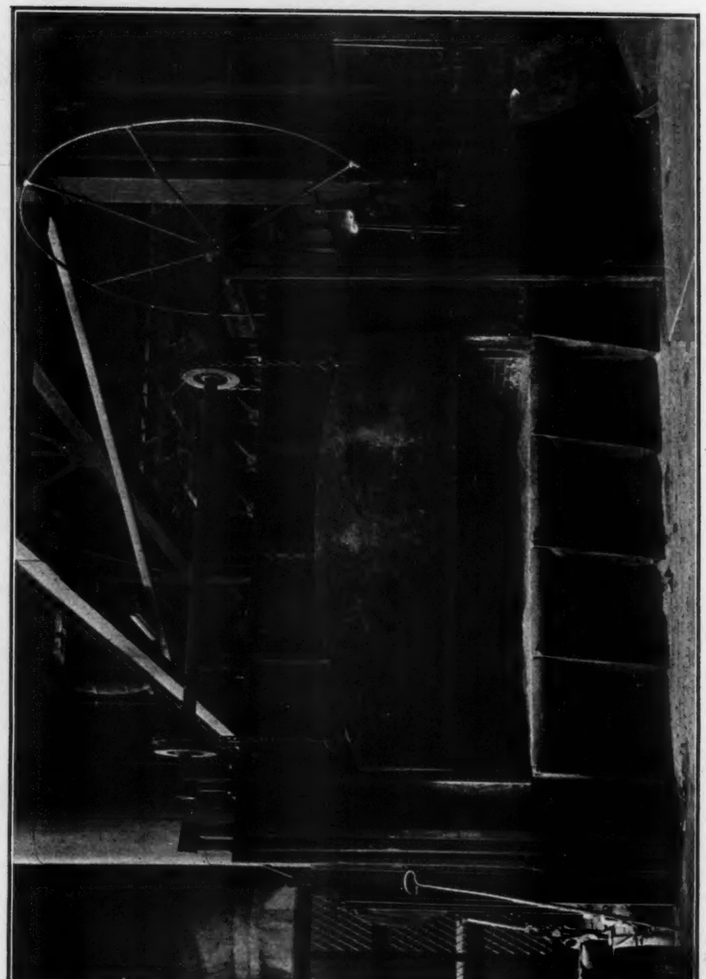
CROSS-SECTION THROUGH THE FREIGHT CAR REPAIR SHOP AT MCKEES ROCKS, PA.



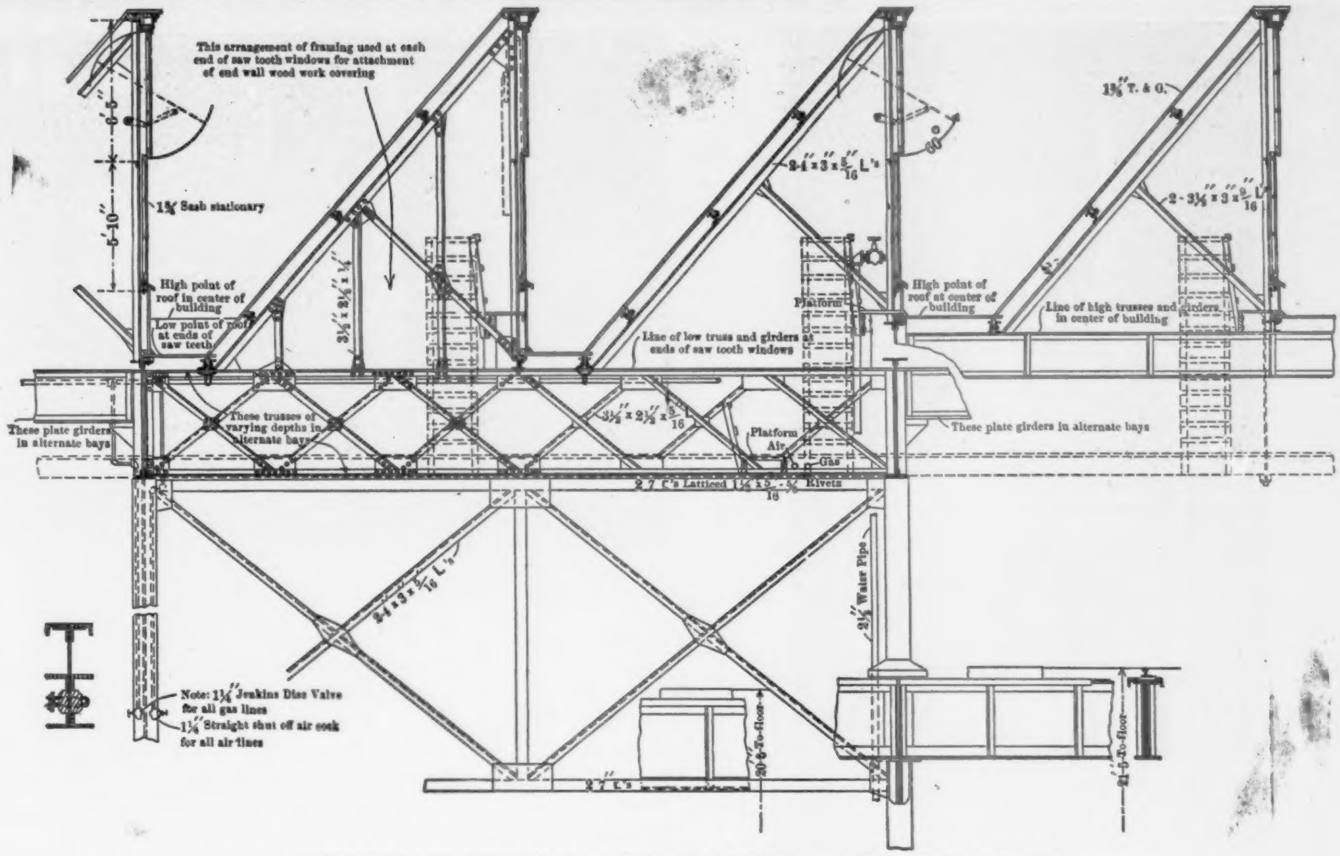
DEVICE FOR HEATING DAMAGED PARTS IN PLACE.

STEEL CAR REPAIR JACK.

PORTABLE RIVET HEATER.



FURNACE FOR HEATING DAMAGED PARTS.

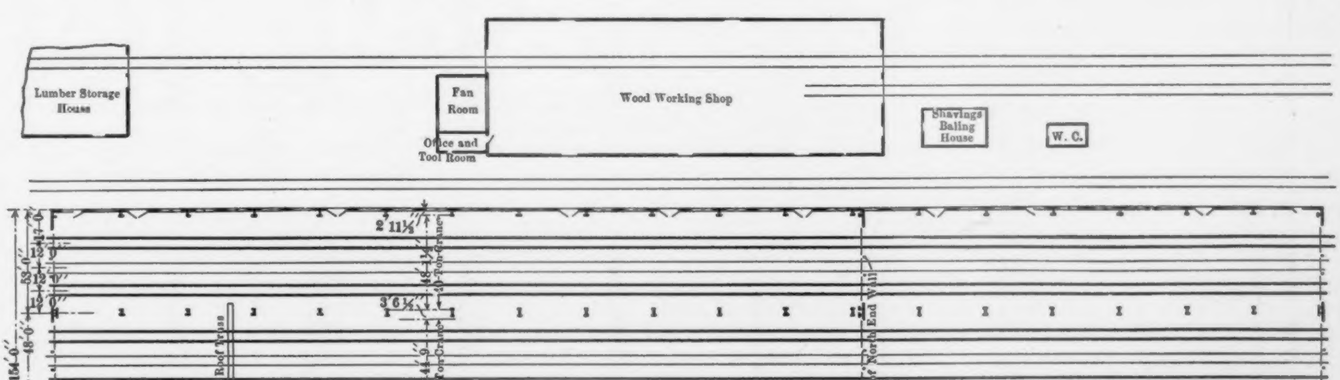


DETAILS OF SAW-TOOTH ROOF CONSTRUCTION OF THE FREIGHT CAR REPAIR SHOP.

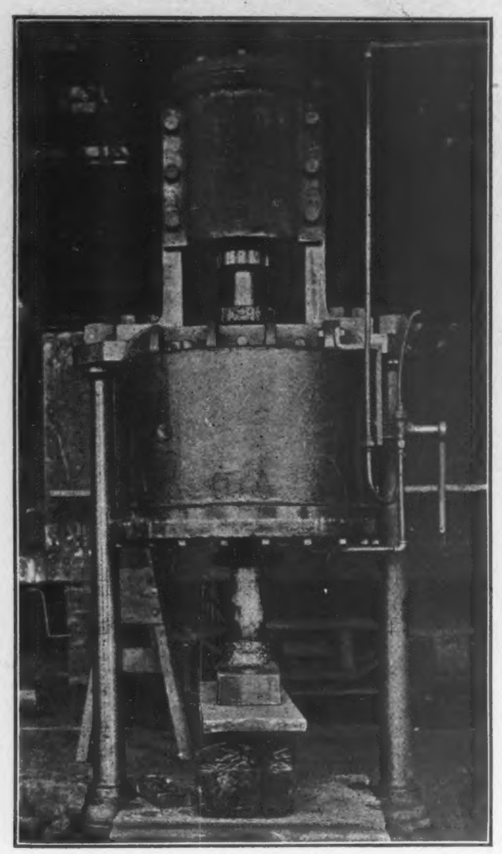
ated riveter for assembling the different parts, such as riveting the draft lugs to the draft sills, etc. A combination triple punching and shearing machine is to be added, capable of punching and shearing flat, angle and round iron. Beyond this is quite a large storage space for new parts and at the end of this portion of the shop a pipe fitting room, equipped with a rack, benches and pipe bending apparatus, is partitioned off. Extending over the middle of the extension or bay is a 10-in. I-beam track upon which two Yale & Towne duplex ½-ton hoists operate. These are used in connection with the handling of repair work and of the heavier pieces of material in the storage space.

It is possible to straighten many parts which are damaged without removing them from the car. These are heated in place by the burner illustrated, which uses natural gas mixed with air, the proper proportion being obtained by regulating the two valves. The device is very simple, consisting of a boiler plate box with a number of small holes, about 1/16 in. diameter in it, as shown. Three coke furnaces are used for heating rivets and are looked after by the rivet boys. Each furnace supplies rivets for four gangs. For work outside of the shop the portable forge, which is illustrated, is used. It is 16 in. in diameter, 12 in. deep and burns coke. The ash chamber, in which the air is also admitted, is about 7 x 7 x 6 in. deep.

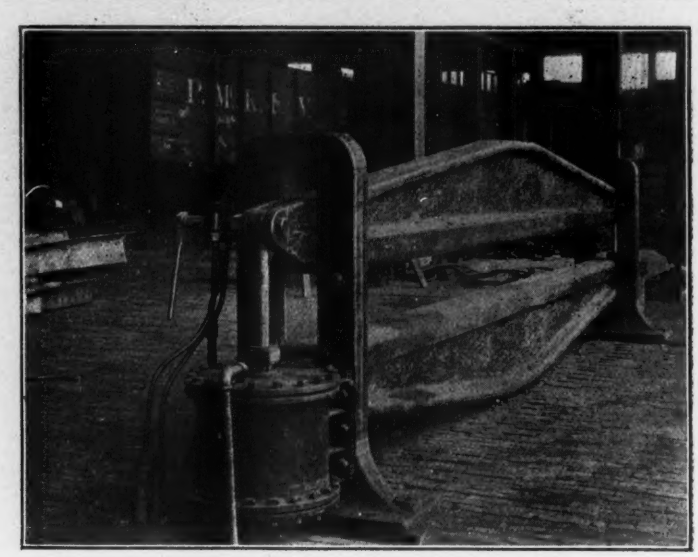
The steel car jack, located as shown on the plan view of the shop, and shown in detail in the accompanying drawings and photographs, is a unique device and has been used with very satisfactory results for straightening the bodies of cars which have been badly twisted or distorted. It consists of a steel frame, anchored in concrete, fitted with a number of movable jacks. If the car body, or any portion of it, is badly damaged, or twisted, it is moved under this framework and with the aid of blocking in connection with the movable jacks it can usually be forced back



PLAN VIEW OF FREIGHT CAR REPAIR SHOP.



SMALL AIR PRESS.

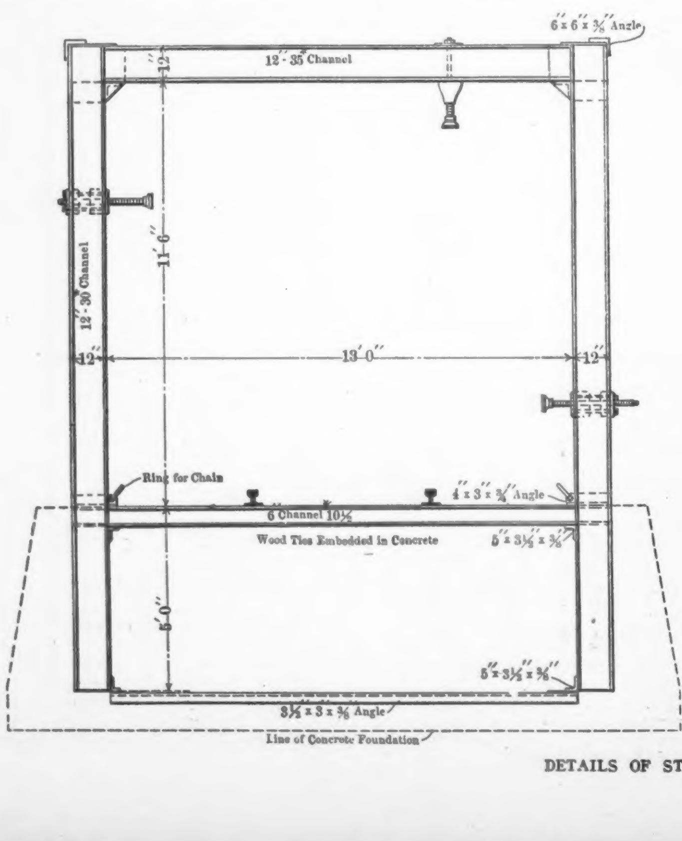


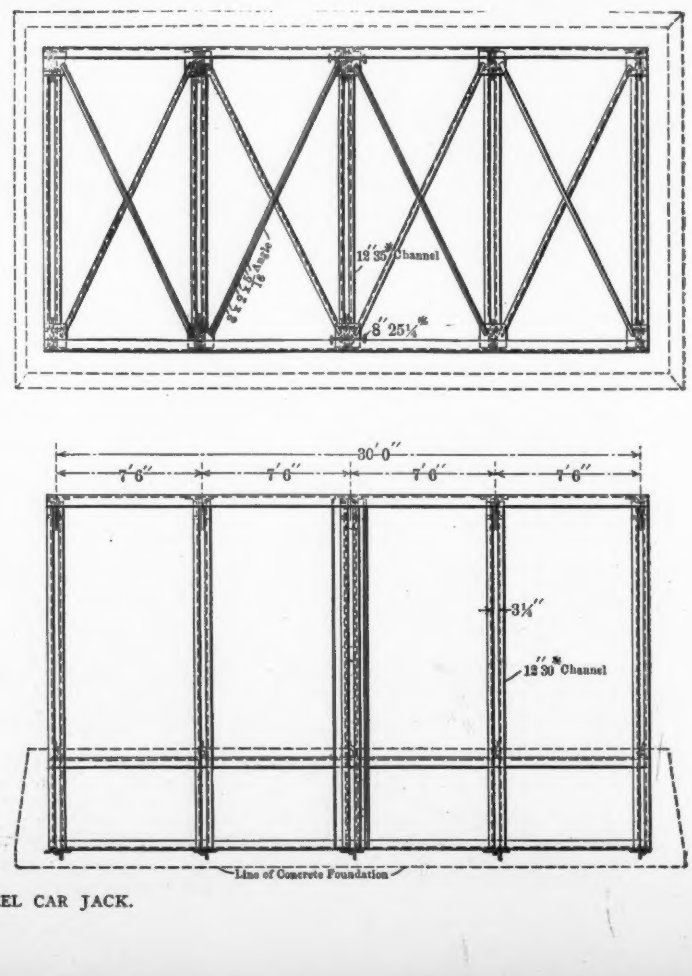
AIR OPERATED FLANGING CLAMP.

into shape with very little difficulty. The bodies are held securely in place by chaining them to the connections which are fastened to the lower part of the posts and anchored in the concrete. The saving of several hundred hours of labor has been possible in a number of instances, due to the use of this device.

The steel car force is divided into gangs of two men, each gang taking care of all of the repair work upon the car to which it is assigned, except the air brake work and the packing of journal boxes, which are looked after by special men. All of the work is done on a piece work basis. It is possible to use gangs of only two men to advantage because all of the heavy lifting is done by the traveling cranes. The three cranes are looked after by two operators, as the work can be so arranged that it is never necessary to have all three of them at work at the same time. In general the cars enter at the north end of the shop and when finished are taken out at the south end. If a car is finished ahead of those in front of it, it can easily be swung over on the material track, by the traveling crane, and moved out over that track. At the present time about 150 heavy steel car repairs are being made per month.

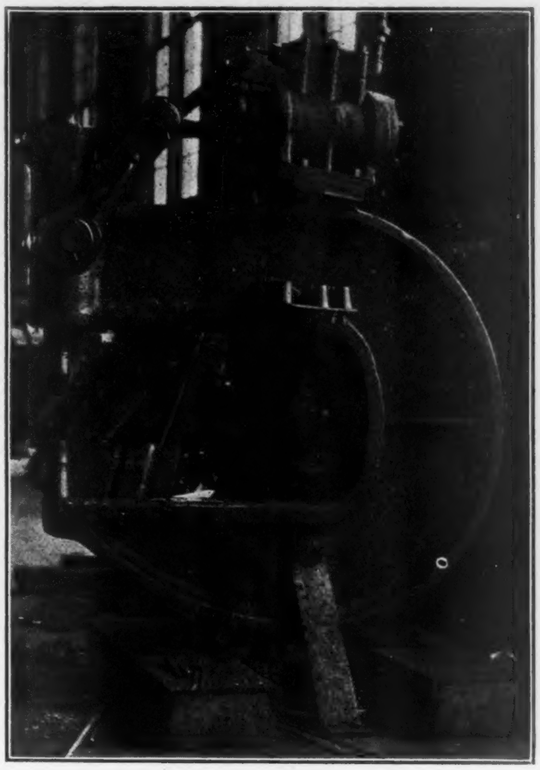
It has been found advisable to repaint the cars at intervals of about four years, when possible. They are painted with the New York Central Lines standard color. The paint is applied with spraying machines, which have been developed by Mr. W. O. Quest, the foreman painter. These machines have been used for a number of years and careful investigation has shown that the paint can be more evenly applied by the sprayer and penetrates much better than when applied with a brush. The operation of the spraying machine does not require highly skilled labor. The





DETAILS OF STEEL CAR JACK.

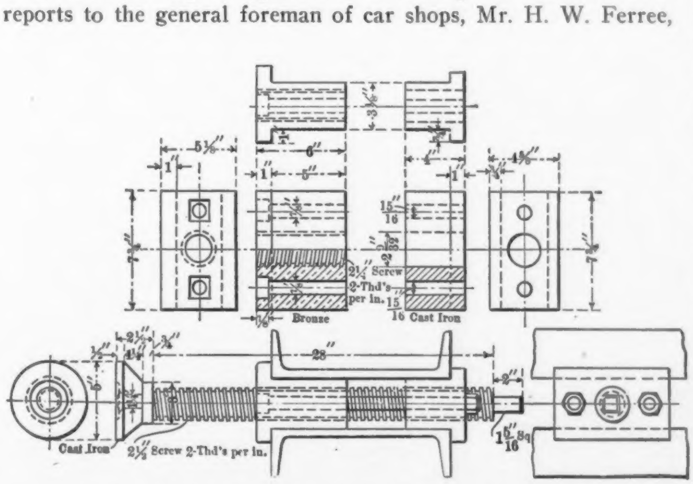
writer watched a car painter who had had no previous experience in painting, and who had just been employed, and was painting his first car. It required five minutes to spray one side of the car and in 20 minutes he had completed the first coat on the car body satisfactorily. It is possible to apply the paint four or five times as fast with a sprayer as with a brush and at least ten per cent. less paint is required. The cars are thoroughly cleaned with wire brushes and scrapers before being painted and



AIR OPERATED RIVETER.

each car is given two coats of paint. The spraying machine is also used for painting the trucks. The insides of the cars are not painted. A number of experiments have been made with different materials, with the idea of protecting the inside of the car from corrosion, but the friction of the lading has in each case destroyed the covering in a very short time. Experiments are at present being made with crude oil which promises to be more successful.

The steel car repair department is in charge of a foreman who reports to the general foreman of car shops, Mr. H. W. Ferree,



SCREW JACKS USED WITH STEEL CAR JACKS.—FOR METHOD OF APPLYING SEE OPPOSITE PAGE.

who reports to Mr. G. E. Carson, master car builder. We are indebted to Mr. L. H. Turner, superintendent of motive power, to Mr. W. P. Richardson, mechanical engineer, and to the above named gentlemen for information and drawings.

HANDLING LOCOMOTIVE SUPPLIES.

BY E. FISH ENSIE.

This article will present the main features and some considerations in connection with the practical care, upkeep, supervision, and economy in the handling of engine equipments, based on an intimate experience of several years in this field of work, and covering the practice of a number of roads.

In general throughout the United States the expenditures for these supplies represent so small a portion of the operating costs, and are scattered over so wide an extent, that where railway officials and their staffs can find opportunity to divert their attention from questions pertaining to the immediate getting of the traffic over the road, they concern themselves with larger and more profitable problems. For the most part, therefore, there is no systematic supervision, accounting, or care for engine supplies. Some division officers will take an interest and better conditions for a time; others will let this minor item of expense go in the press of bigger matters; occasionally a general officer, such as a general manager or a superintendent of motive power, will attempt systematic regulation with the hope of some good general results, well worth while, even if the gleanings in particular localities are small; in such cases beneficial results may be temporarily secured. But the roads that are steadily achieving good practice in this respect in this country can be counted on the fingers of one hand. Even on casual observation it will become evident to those who are curious enough to get at the main facts, that there are large and unnecessary wastes of these supplies, and that as a consequence the average cost of this item of conducting transportation expense is four or five times what it should be.

This statement is no exaggeration. There are some roads where the total results are not so bad; there are others where they are much worse; the proportion named is a fair average of what obtains over the entire country, and is taken from the official records and accounts of the railways employing over half the locomotives in the United States.

There is spent annually in the United States between $4,000,000 and $5,000,000 for locomotive supplies alone, and nearly an additional million for labor in connection with the maintenance of this equipment. The cost of upkeep per locomotive per year will thus be seen to average above one hundred dollars, an altogether excessive figure. The full value of the equipment on an ordinary locomotive will vary from an average of $40 on some roads, to about $100 on others; the theoretical value of the equipment that is supposed to be on each engine will, as a rule, be somewhere between these limits. However, on some roads, and on some divisions of almost all roads, equipments will be incomplete; and in other instances there will be large overages. On an average each locomotive in the United States (and I emphasize the country, since they do things differently abroad, where they have a keener eye for detail, because they are not so swamped with traffic and must extract their earnings out of small savings and economies) will be completely re-supplied with its tool and supply equipment, as far as value is concerned, twice over each year.

Some articles, such as brooms, scoops, headlight chimneys, flags, fusees, torpedoes, and a very few others, actually require replacement oftener than this, but these articles are among the very least in value, and the more expensive items, such as re-railing frogs, jacks, blizzard lamps, screw pipe wrenches, etc., should last many years without renewal.

I have never seen what could be considered a minimum attained cost in this respect on any American railway, but from such thoroughly good and creditable performance as has been kept up month after month on particular divisions of certain roads, where the possibility of one division's enginemen stealing from another was carefully guarded against and effectually prevented, a fair figure for a reasonable attainment can be had. This figure is from 70c. to $1.50 per month for the cost of the supplies themselves, according to the quantity of the equipment carried on the engine and the geographical location of the division (west-

ern expenses being higher), and an additional sum of 75c. to $1 for all supervisory, clerical, and labor expense, or a total of between $1.50 and $2.50 per month per engine in actual service. Of course, much lower figures have been, and can be attained; some engineers, where the pooled system of engine assignment is not in effect, after being provided with an equipment, manage to hold on to it, and get good service from it, for years with a trifling upkeep cost of a few cents per month. However, it would be no argument to condemn the handling of engines in pool, because it made the cost of engine supplies rather higher; that would be surely looking through the wrong end of the spyglass. A figure, covering the total of all costs relative to engine equipments, in the neighborhood of $2 per month, or $25 per year is amply generous, and will enable the company giving the proper attention to this matter, to provide the very best of equipment, the very finest and most durable of oil cans, torches, water glasses, tools, etc.; to have at all times a complete equipment in

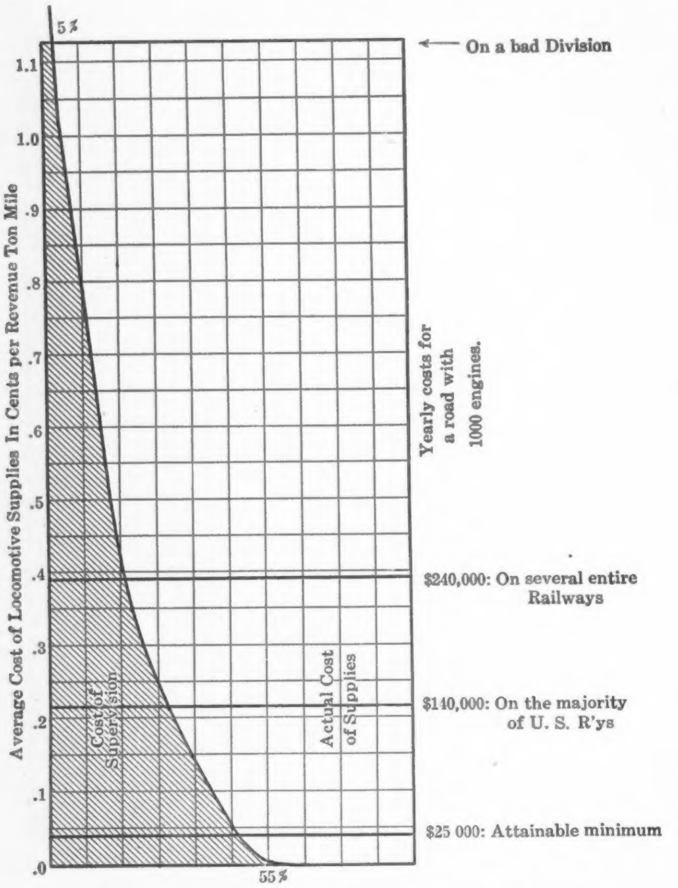


FIG. 1.—ACTUALLY OBSERVED COSTS OF HANDLING ENGINE EQUIPMENTS.

perfect condition on every engine in service, and to have them carefully and systematically looked after and checked up.

How many roads in the country have reached this condition of affairs? Yet the most of them pay four or five times the price of this practically perfect service, and get a wretched result; they pay this sum for the supplies alone, and an additional amount for labor to look after the supplies (perhaps), labor that is assigned other duties, and is underpaid, hence inefficient.

A good supplyman in the east will cost from 18c. to 22c. an hour; west of the Mississippi the rate will range from 25c. to over 50c., according to the conditions and the man. Supplymen, or equippers, or tool checkers (they are variously designated, and have varying functions) rarely get such rates of pay, and as a consequence at division points and storehouses, where the railway company might by spending $10 to $20 per month in higher wages to such a man, securing reasonable economy in these supplies, they lose from $50 to *over* $500 per month, at each of these points by getting along with poorly paid, inefficient, and wasteful help.

Of course, the mere question of wages to these men is not going to solve all the difficulties and automatically secure proper economy and care of these equipments. There must be at the same time an intelligent selection of these men, a certain training, and a comprehensive scheme, with traveling inspectors, so as to bring about a general uplift and uniform improvement in all respects.

Equipment should be redesigned in many cases; the list of articles supposed to go on each engine should probably be revised and a number which in modern times have no further usefulness, eliminated. The accounting should be thoroughly gone into, and a thorough system for checking results and costs in detail, and placing individual responsibility, put into effect. All these things will cost effort, and brains, and trouble; they will cost a certain amount of money; *they will pay for themselves many times over, and within two or three months' time, if properly pushed. It is entirely feasible to make these improvements pay for themselves out of the second month's reduction in wasteful expenditure.* I say two months, because it takes a certain amount of time to investigate accounts, to find out what is actually going on, and to secure the necessary approvals for amplification of the accounting system to give the figures that are needed for close and careful supervision, promptly, unerringly, and specifically. The geographical extent of the road will also have a bearing on the speed with which results can be secured, a widely extended road requiring more time than a dense, compact one; however, the long road will probably have

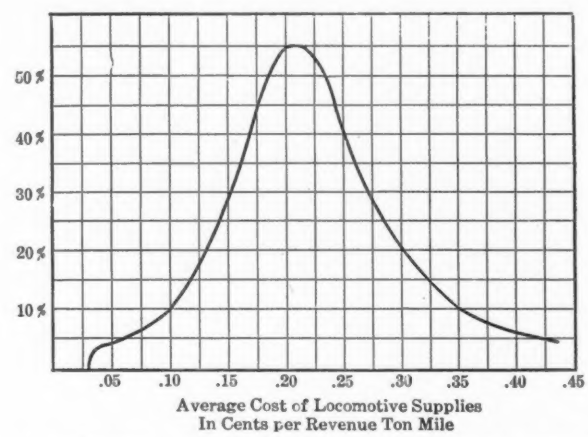


FIG. 2.—PROPORTION OF RAILWAYS HANDLING ENGINE EQUIPMENTS AT VARIOUS DEGREES OF COST.

much higher costs to begin with, so that larger results can be obtained.

Figure 1 represents in chart form the costs, in decimals of a cent per revenue net ton mile, of upkeep of engine equipments on three specific roads, and on one specific division of one of the roads. The basis of measure is taken in ton miles, although it is realized that there are certain disadvantages in connection with the use of this unit. A preferable figure, perhaps, would be the road unit adopted by the statistical departments of many railways, consisting of a ratio between the weight of locomotives on drivers, the engine miles, and the costs to be measured. But this figure is not always so readily ascertainable as it should be, and so the more familiar ton mile unit is here employed for illustration. The diagram also shows the costs in annual totals, and the proportion of supervision and labor in that cost at different degrees of efficiency. The most effective results seem to be secured where the supervisory cost equals, or slightly exceeds, the actual cost of the supplies used; that is, at that point there is the minimum total expenditure. As the supervision is relaxed, the waste of the supplies, and irregularities of all sorts, appear and grow. It should be explained also, in connection with this diagram, that the yearly costs represent the expenditure of a road having 1,000 locomotives.

Figure 2 is another diagram showing what proportion of the railways of the United States fall under each degree of expensiveness in this small item of maintenance. Thus over 50 per cent. of the railways pay more than .2c. per ton mile; less than 10 per cent. pay as little as .1c. and another 10 per cent. pay

about .35c. These figures are in tenths and hundredths of a cent —not in whole cents. The diagram is only approximately correct as the figures for all roads are not available; but it is sufficiently representative of the large majority of them to be trustworthy in the main. I doubt if any portion of the curve will be found to be more than 4 per cent. in error. This is not close, but it is close enough for the purpose intended.

The general aspects of this question have been presented; they may be recapitulated:

Engine equipments are very necessary, and sometimes must serve in cases of great need; their value at that time far exceeds their cost.

In order to have them available at all times, they must be kept up in good condition, must be checked over, and shortages guarded against. Rusty jacks are useless; a wrecking frog that was left last week near the scene of a freight car derailment and subsequent replacement (of the car—not the frog), is of no avail; long oilers with leaky spouts are expensive and wasteful; scoops, too, have a way of mysteriously disappearing in roundhouses—really there is no mystery at all. All these little defects of lack of systematic care must be remedied if good service is to be given, and that is the first desideratum.

Because of waste, this item of expenditure is now excessive on almost every railroad in the country.

Improved service costs nothing; it is paid for out of economies early effected; the cost is merely a case of accounting.

Mere increase in wages will not secure the best results, or perhaps any results at all. Yet a first class and well trained man, with perhaps as much jurisdiction in his field as a general boiler inspector has in his, and with probably the same pay as the usual general boiler inspector gets, is not too high to go. Such a man, if properly selected and thoroughly qualified for his task, will accomplish much more, and that more speedily, than a cheaper, less experienced man. And right here let us admit that the usual general boiler inspector is not paid nearly enough for the importance of his duties, nor does he have the authority he should have. If the position were made more attractive, the very best men could be secured, and what that would pay in boiler care!

The more thoroughly the problem is worked out and studied from the very start, and the more progressively it is pushed, the larger will be the ultimate gains and the sooner will large gains be apparent.

By the pursuit of proper methods any road should reduce its costs in this respect to a maximum of one-half mill per net revenue ton mile; any general manager or other interested party can tell how much can be added to the net earnings of his road by this standard; the annual economies will foot up from $10,000 to over $200,000 according to the size of the road; if groups of roads be taken, the totals will be larger still. Such accounts, although small compared with other expenditures, are yet well worth the picking in these hard times when retrenchment is in order.

If the items of locomotive oil and waste, and of caboose equipments also fall under the same jurisdiction, the gross amounts dealt with are more than trebled, and the effectable reductions also correspondingly increased, although perhaps not in equal measure. And these other items admit of being easily and naturally handled in conjunction with the engine supplies. The proportionate supervisory force does not have to be so large. On a system of about the size of the Pennsylvania and its controlled lines, a net expense reduction of nearly a million dollars should be quite possible, in these accounts alone.

Having summarized the aims, and results to be secured, we can proceed to a discussion of the detail methods involved.

Accounts.—These are now provided for under numbers 78, 81, 82, 87, 90, 91, and 95, more particularly, as indexed on page 19 of the Third Revised Issue of the Classification of Operating Expenses, as prescribed by the the Interstate Commerce Commission. It will be found desirable, and in fact necessary, to subdivide these accounts, and to re-group them for purposes of supervision and information. For instance, pay of tool checkers, a roundhouse expense, should be separated from other items of roundhouse expense, and should, in the summaries, be added to the totals of the costs of supplies furnished to locomotives, so that the proportion between supervision and material may be ascertained and the amount of the net reduction be determined.

Matters will be greatly simplified if there is but one set of fundamental records, upon which all later figures, and arrangements of figures, are based. Only in this way can consistency in the accounts, and a proper balance, be secured. These fundamental records should be:

Abstracts from the payrolls and expense vouchers, covering the pay and expenses of all labor and supervisory talent used in connection with this plan.

Duplicates of all orders placed for the purchase of equipment, showing where orders originated and the necessity therefor. Advice should be given of the cancellation and of the delivery of each order cancelled or filled.

Regular and frequent statements should be made showing material available in each storehouse.

Duplicates of each requisition made on stores for each article should be furnished; it is recommended that a special requisition blank for these supplies be adopted, or the regular form specially designated in some way. These requisitions should indicate:

The article drawn.
The date.
The account chargeable.
The engine or purpose for which drawn.
The man drawing it.
The man filling it.
The man or men (in the case of an engine, the engineer and fireman) for whose use intended.
Whether the article is new or second hand.
Whether the old article was returned when the new was drawn; if not, an explanation, on proper form, of why needed.
The place or store where drawn.

From these fundamental records will be compiled recapitulations and summaries, by articles, by places, by engineers, by firemen, by engines; averages over divisions can be shown of costs per engine per month, or per engine mile, or ton mile, or other convenient unit, for material (or any article), and for labor and supervision. By means of such records, which are neither difficult nor expensive to keep, the excessive costs can be located, investigated, and corrected. Costs will melt away like snows under a summer sun; costs cannot remain excessive and salient under high illumination and burning scrutiny.

And the recapitulations should reconcile very closely with the statements compiled and approved by the auditors; all records, so far as practicable, should be prepared by members of the accounting staff, and their time, if of any considerable proportion, separately apportioned so as to be charged against the cost of effecting the reductions.

Filling Requisitions.—Requisitions for the purchase or acquirement of new equipment material should be checked by the man in charge of this work; useless expense may thus be nipped in the bud, and a control may be had over the selection of the material, which should always be in conformity with the adopted standards of design and specification.

Requisitions on local storehouses should, wherever practicable, be handled entirely by the man locally in charge of supplies and equipments at each place. This man should be responsible for seeing that engines are properly provided for, and the practice of enginemen running to storehouse and filling their own requisitions should not be tolerated where it can at all be avoided.

Standardizing Equipment.—All equipment should be reduced to uniform standards and specifications, and drawings made of each article. Articles may then be ordered by number, without error. If practicable, the items of the equipment that are similar to those used in the shops and roundhouses, such as hammers, chisels, etc., should be of distinctive design, so that if they are appropriated by shopmen they can be detected. The engineer's hammer might have a wedge pein, for instance, while the shopmen generally use a ball pein; the engineer's chisel might be of hexagon steel.

Not only should all the tools be thus standardized, but the tool boxes should be similarly standardized, and their location upon engine and tender likewise definitely determined. Moreover, the tools and articles that are to go into each box should be foreordained, and the boxes so designed that everything may have its place. Those boxes that need them should be provided with locks, preferably master-keyed in some way; locks, hinges, hasps and boxes should be, as far as possible, protected from being broken into by substantial design. In ascertaining standards, the best articles that can be found for their purpose should be secured and tested out, and, if successful, adopted.

All this standardization, which is an important factor in the larger ultimate permanent economies, need not be a source of alarm to the railroad management; a draughtman's services may be required for as much as a month, in order to get out the drawings and designs. But the substitution of the standardized material for the old material on hand and in use will be a gradual process. Old equipment will be kept in use until worn out, unless markedly defective; the older equipment might be retired to the branch line runs, or those engineers who showed a tendency to take care of their equipments might be rewarded by being given new sets on their engines, relegating the older

material to the careless men. Standardization is rather a provision for the future than a move for immediate gain.

Checking Equipment.—Perpetual inventory of all equipment at all times should be kept. The man in charge should know:

What articles are needed, and where and why.

When they will be got, and at what expense.

Stock on hand at each store.

Equipment located on each locomotive (different classes of service will have different requirements; an engine with electric headlight will have to carry spare carbons, for instance, and perhaps a few lamp parts).

Each article that passes out of service; each replacement that takes place, and why.

To insure the engine inventory being kept up, to put the local supply man or equipper in a position to know the needs of each equipment, so he can fill them, there should be periodical and frequent inspection of equipments, preferably every trip at the principal division points. The equipper or inspector, with his master-key, is able to tell almost at a glance whether everything is in its place in the standard boxes and make out a complete report on a form for the purpose. This inspection will average from 3 to 6 minutes per engine. (See Figure 3, standardized box, facilitating inspection.)

If engines are inspected, both going out and coming in, there is an absolute check against the engineer. Everyone should be provided with the proper and regular equipment all the time, so there is no excuse for pilfering from each other. Such cases are very hard to catch, but when caught should be very severely dealt with. Tools may be marked with the engine number, but this is often a very inconvenient procedure.

Caring for Equipment.—Engines going to shop, unless in charge of a messenger, who would be checked up like an engineer, should have all equipment removed and either placed in a special box and sent along, or kept at the home division point. If the equipment is marked it should go with the engine, otherwise it may be put at once into service, where it can earn the money invested in it, and other equipment may be placed upon the engine when it comes out of the shop. If the records and accounts are properly kept, there need be no injustice done either to an engine or to an engineer in his record by this plan.

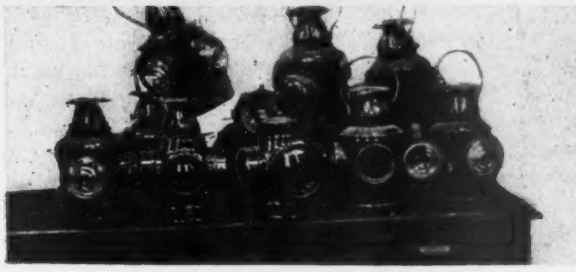
When articles are damaged they should be taken out of service and replaced by sound articles. The old ones will be accumulated and repaired, either by sending to the central shops (a rather slow process, of more trouble than economy except in the case of the heavier tools, such as switch chains, jacks, and blizzard lamps), repaired in the local shop, or even tinkered up by the equipper if he has the time and the knack. Figure 4 shows a box car which serves as such a den for an equipper, an ex-engineer; Figs. 5 and 6 are interiors of this car. Fig. 7 is another such equipper's storehouse and repair shop.

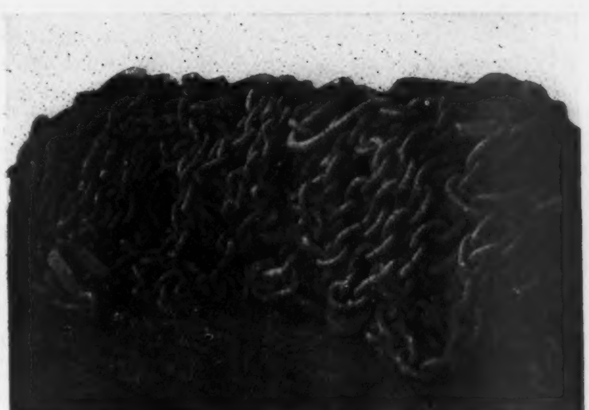
The equipper makes it his duty to go about shop yards and pick up scrap and old material and see that it is put in shape. This material is used up instead of drawing new supplies. Large savings are secured in this way. Storehouses whose issues were running $1,200 to $1,500 per month, find that their issues drop to $300 or $400, on averages extending over many months, when this policy is resorted to; issues averaging $650 drop to less than $200. If the old equipment is properly cleaned, and put in good shape, there can be no valid objection to its use by the men.

Figures 7, 8, 9, 10 and 11 illustrate valuable equipment that was picked up in this way during two months at one place, besides what was issued from this old stock. This was put in shape, and the pictures show the surplus. These pictures represent material of the value of over $400. Such savings, when systematically pursued and directed over an entire railway sys-

FIG. 7.—SUPPLYMAN'S STOREHOUSE AND REPAIR SHOP.
FIG. 3.—STANDARD TOOL BOX.

FIG. 4.—OLD BOX CAR EQUIPPED FOR SUPPLYMAN.
FIGS. 5 AND 6.—INTERIOR OF BOX CAR. FIG. 5.—DESK. FIG. 6.—OFFICE AND GAUGE TESTING MACHINE.





FIGS. 7, 8, 9, 10 AND 11.
VALUABLE EQUIPMENT PICKED FROM SCRAP, REPAIRED AND PUT BACK INTO SERVICE.

tem, roll up handsome aggregates, and always look well in the decrease column of the expense account in the annual report to the stockholders at the end of the year. And if the company shows that it has an interest in thrift, the example will be a good one on its employees.

Below is a statement of one month's repair work, done by the supplyman, or which he had done at the local shop, on old and otherwise useless equipment:

Class of Repairs.	Number repaired.	Material charges.	Labor charges.	Average cost.
Grinding chisels	93	$0.00	$0.60	$0.01
Applying hammer handles	55	1.65	.60	.04
" pick "	6	.75	.10	.14
Overhauling 12" screw-wrench	12		1.57	.13
" 15" "	33		3.27	.10
" 18" "	3		.67	.22
Soldering engineers' oilers	22		1.30	.06
" tallow pots	22		.97	.04
" two gal. oil cans	9		.65	.07
Repairing water glass lamps	10		.32	.03
" tin torches	7		.65	.09
" marker lamps	21		3.91	.19
" 24" screw jacks	1		.22	.22
" 18" " "	2		.44	.22
" No. 8 Norton jacks	3		.65	.21
" 6" screw jacks	6		1.34	.22
Straightening pinch bars	12		.50	.04
Cutting off coal scoops	39		.80	.02
Total		$2.40	$18.50	
Grand total			$20.90	

In this particular case over $200 worth of material was saved and used, the cost of repairs being but $20.

Conclusion.—One might go much further, if space permitted, and give in detail the exact accounting forms used, the number of men necessary in each capacity on a road, of say, 1,000 engines, etc.; in other words a complete sketch of all the items of cost in connection with the establishment of such an equipment supervision system might be given, both with respect to amounts, and various departments of the work, as well as with reference to the progress of the work, and its probable extra (if any) cost from month to month, together with results secured month by month.

It is sufficient to say that by the end of the first year after work in this direction has been commenced, a reduction of expense, coincident with much constructive improvement in service, of at least 20 per cent. net should be expected; in the second year the results should be still better, and the reductions more than double this figure; in the third year the full measure of efficiency and economy should be attained, and thereafter kept up.

It is suggested, in view of the limited experience in this direction, that inducements for economy on the part of the supplymen be held out in the way of definitely promised (and substantial) increases in rate of pay, provided certain results are achieved; that the co-operation of enginemen may be obtained by periodically giving prizes in cash, or in other valuable consideration, such as a specially fine personal kit of tools, or card transportation privileges, these rewards to be for conspicuous care of tools, etc.

To sum up: While not a dollar should be invested in a new tool when an old one will do just as well, or nearly as well; while only such labor and brains should be employed as are actually seen to bring about economies, more than paying for the supervisory cost, etc.; and while the rates of pay should be increased only as a direct result of economies effected; it is advisable to keep in sight the fact that the important thing for the interest of the railway is to—*First: Keep the equipment up in the very best of shape. Second: Reduce the total of all expenses in connection with handling it, even though this does proportionately or absolutely increase the labor and supervision cost.* And if the job is worth tackling at all, it is worth tackling well and thoroughly, so as to get full, and not half results. Give the man you place in charge your backing, and he will pay you for it well, if he is the right sort. If feasible, extend his duties to cover the caboose equipments, and the oil supplies furnished engines; this will result in greater economy in handling, as well as in larger net results at the year's end.

STEEL PASSENGER EQUIPMENT.*

By Charles E. Barba and Marvin Singer.

THE UNDERFRAME.—PART II.

Synopsis.

Graphical Analysis.

Static Loading.—For purposes of illustration we have assumed a center sill loaded as indicated, *i. e.,* Form 2. The methods followed in this example are applicable to any class of lading whatsoever. The lading diagram (Fig. 11) needs explanation to make it easy to clearly follow the bending moment curves. There is a definite uniform center sill lading which will vary with the detail design of the flooring and the weight of seats used, and will include half the live load. Likewise there is a certain uniform side sill lading extending between body end sills which depends upon the cross section and the weight of seats and the live lading as shown in Fig. 8, for any special case.

The uniform side sill loads are transferred to the center sills as concentrated loads by the transverse side sill supports, namely P_1, P_3, and a portion of P_2. In determining the value of each of these concentrated loads it is assumed that each cantilever supports that portion of the side sill which extends on either side of it to a point midway between the successive cantilevers. The other portion of P_2 is one-half of the vestibule load which is transferred to the center sills through the body corner posts, the end door posts and the body end sills. This must be added to the portion of uniform side sill lading that the body end sill carries to the center sills to complete the local concentrated load at this point. There now remains for P_1 the remaining half of the vestibule weight. This vestibule weight should include all the fittings which are necessary to make the car complete, such as draft gear and attachments, buffers, trap doors, diaphragms, etc.

The bending moment diagrams are not drawn to any scale of foot or inch pounds, but show the general character of the curves that will be found from application to any definite car. It has been deemed advisable to show the separate effects of the overhanging and then of the central loads and following these, the combined diagrams, though the latter can easily be drawn at once by superimposing the separate curves in one figure.

Curve 7 illustrates the varying bending moments due to all the dead and live loads, both uniform and concentrated, upon the center sills. This curve is found by algebraically adding and subtracting the bending moment ordinates of curves 3 and 6. These curves are drawn by means of the customary polar diagrams of lading.

End Shocks.—There are several methods which can be used to combine the bending moments occasioned by the end shocks with the foregoing moments due to static lading.

The first step is the determination of the line of action of this force. The friction draft gears are capable of absorbing 150,000 pounds when the buffers become solid against the platform end sills. At this point in the yielding compression the draft gear is still capable of a small amount of movement before going solid, hence the remaining 350,000 pounds for a 500,000 pound end shock and 250,000 pounds for a 400,000 pound end shock must be taken by the end casting. Both of these are transferred to the center sills, the buffing shock at a point above the neutral axis and the pulling shocks below, in the usual case, though it does not matter if this condition is not fulfilled so far as this presentation is concerned.

There is evidently a point through which the line of action of the sum total end shocks can be made to pass, so that the effects of this combined load on the center sills is the same as that for the two separate eccentric forces. Fig. 12 shows that if moments be taken about the resultant line R that the location of this line will be given by the relation G = 3/7 F, or, in other words, G is 3/10 the distance between the center line of the buffers and draft gear and F 7/10. This is for values of B = 350,000 and D = 150,000 pounds. For B equal to 250,000 and D equal to 150,000 pounds the relations as expressed above become G = 3/5 F, G = 3/8 and F = 5/8 distance between B and D.

This will enable the eccentricity H of end shock to be found since the distance from the neutral axis to B and D are known.

Fig. 13 illustrates the condition to be considered with a pulling load. The moment arm is much increased and is shown as J. It should be noted that the moment curve is below the neutral axis in this case. The fact that the deflection Y = △ at a maximum is noted the same in both figures does not imply their identity.

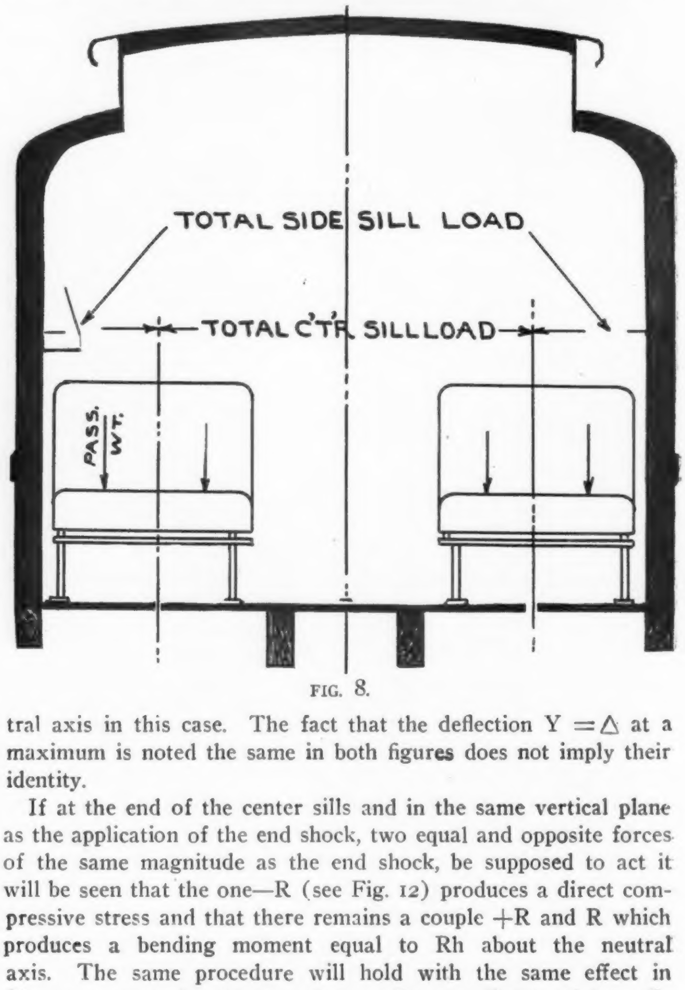


FIG. 8.

If at the end of the center sills and in the same vertical plane as the application of the end shock, two equal and opposite forces of the same magnitude as the end shock, be supposed to act it will be seen that the one—R (see Fig. 12) produces a direct compressive stress and that there remains a couple +R and R which produces a bending moment equal to Rh about the neutral axis. The same procedure will hold with the same effect in Fig. 13, except that here we have +D as a direct axial tensile strain and a moment DJ about the neutral axis.

The effects of this bending moment, which is a variable throughout the length of the beam, upon the various sections of the beam, are hard to properly take care of. The difficulty lies in securing an assumption for a basis of calculation which does not interpose prohibitive mathematical calculations. To assume that the arc of bending of the neutral axis is a portion of a circle is not true, for by solving the general equation of the elastic curve bent according to this supposition the deflection is found to be

$$\triangle = \frac{ML^2}{8EI} \text{ where}$$

M = bending moment.

L = length between supports in inches.

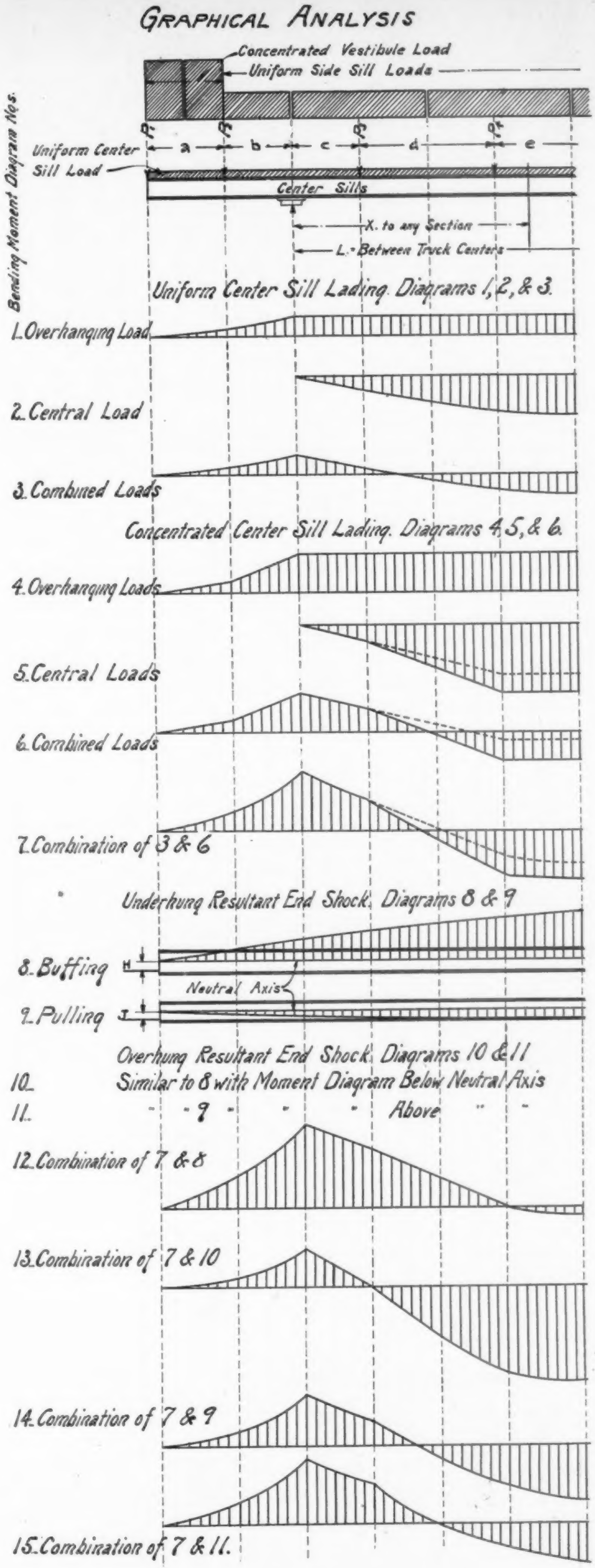


FIG. 11.

E= coeff. of elasticity.
I = moment of inertia.

In this there has been neglected $\triangle^2$, which is an infinitesimal in beams properly designed for stiffness. This value is but 80 per cent. of what it would be for the theoretical curve with a load concentric with neutral axis. This again does not take into account that, as a beam with an end load bends further from the neutral axis the farther the point of such bending be taken from the end, the bending moment is increased continually by this increase in deflection up to the point of maximum deflection. If the same general equation of the elastic curve $M = \frac{EI}{r}$, where r = radius of curvature, be solved with the bending moment arm considered as

$$H + \int_{x=0}^{x=\frac{L}{2}} Y dx$$

the resultant will take the form of a transcendental equation where

$$y = (\text{function}) \sin x + \text{constant}.$$

This introduces circular functions into the problem and the

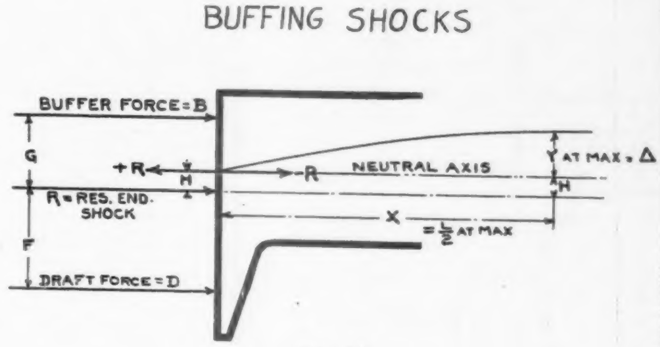


FIG. 12.

maximum deflection at the center can be shown to be

$$\triangle = \frac{RHL^2}{\pi^2 EI - RL^2} \text{ or } \frac{DJL^2}{\pi^2 EI - DL^2}$$

Hence at a maximum the arm of R, or D as the case may be, becomes

$$H + \frac{RHL^2}{\pi^2 EI - RL^2} \text{ or } J + \frac{DJL^2}{\pi^2 EI - DL^2}$$

and the bending moment is

$$R\left[H + \frac{RHL^2}{\pi^2 EI - RL^2}\right] \text{ or } D\left[J + \frac{DJL^2}{\pi^2 EI - DL^2}\right]$$

To draw the curve represented by the transcendental equation would mean laborious calculation and plotting. It will be found to be a very close approximation to assume that this maximum bending moment was produced by a uniformly distributed load over the total length of the beam. This will readily give a curve which can be combined with the other moment curves represent-

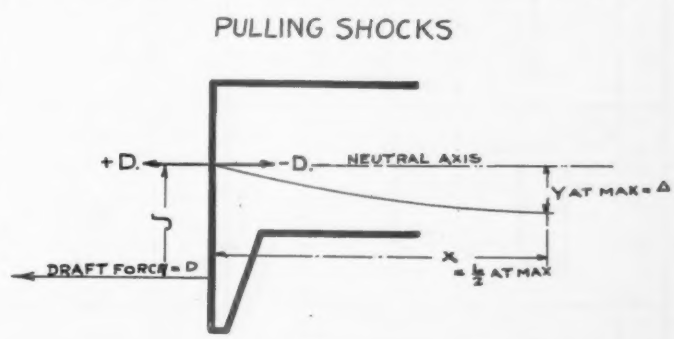


FIG. 13.

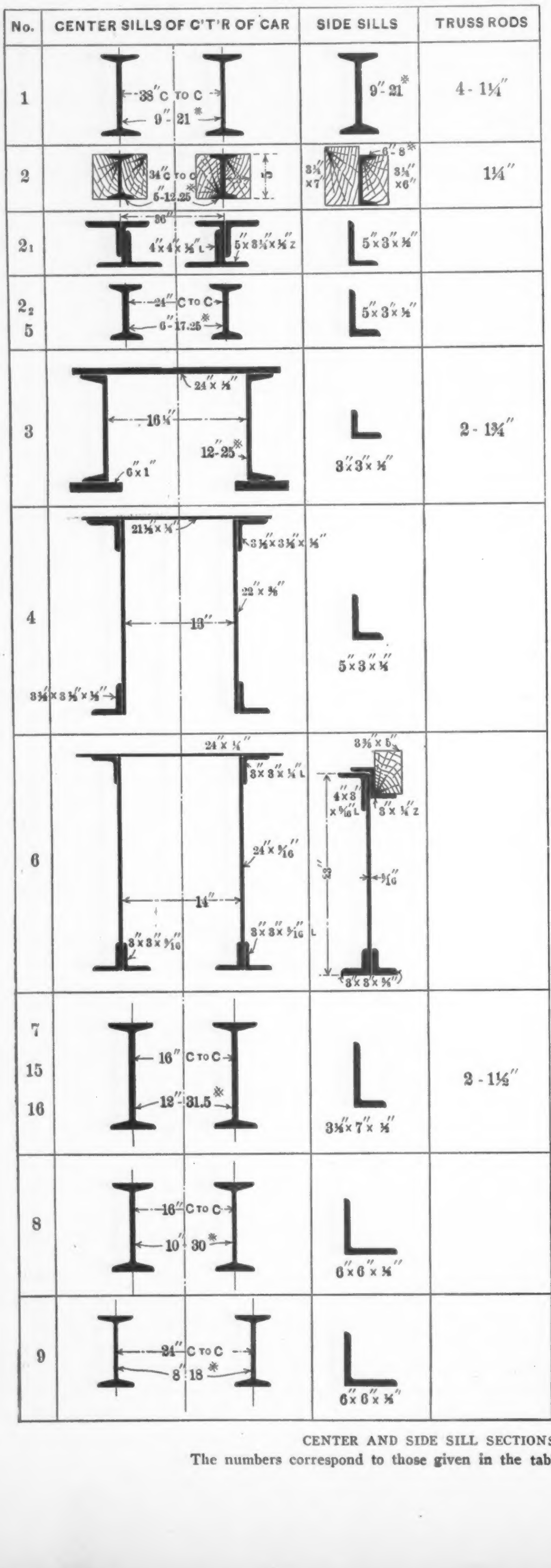
ing the conditions obtaining from static lading. Bending moment curves 8 and 9 are thus drawn.

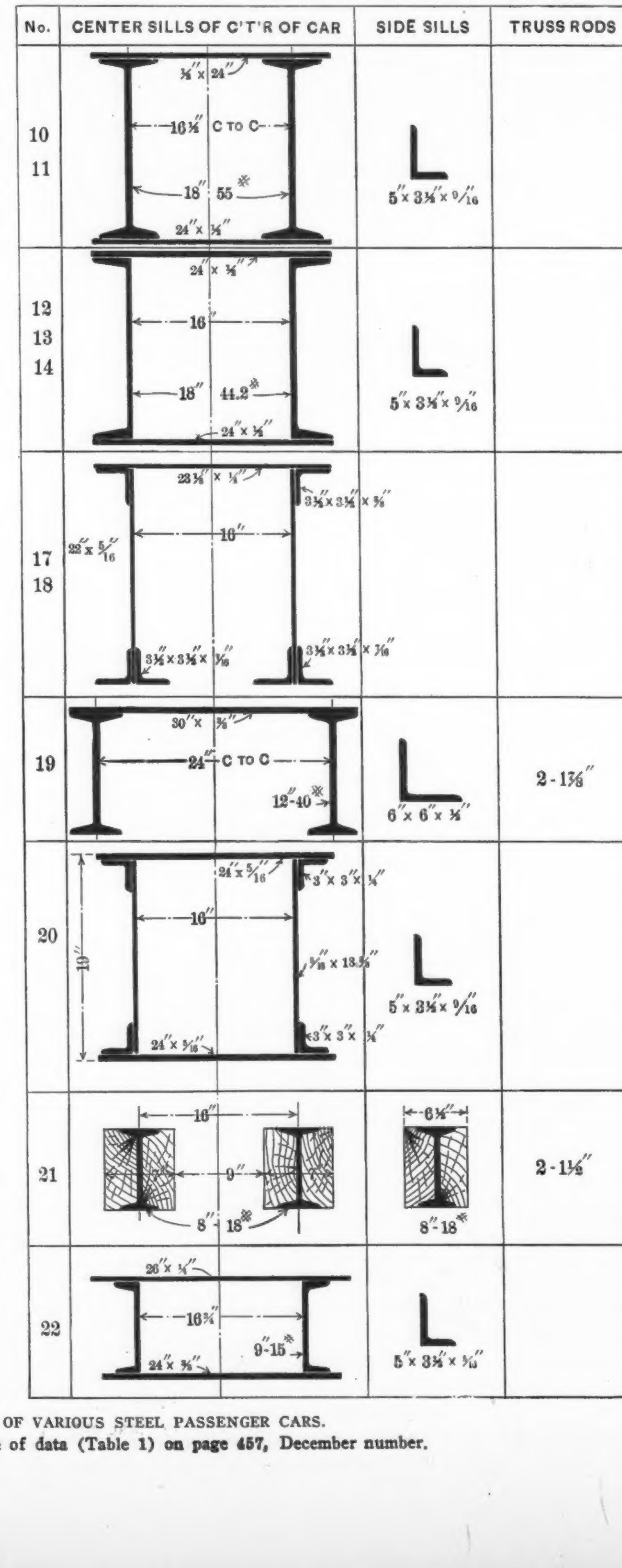
The above procedure is best adapted to the careful investigation of a finished design more than to the preliminary choosing of trial underframe sections. For the latter a ready approximation can be made by considering the end bending moment simply as Rh or DJ and securing the uniform load which will give this corresponding moment at the center of the beam. Thus

$$RH \text{ or } DJ = \frac{wL^2}{8} \text{ and } w = \frac{8RH}{L^2} \text{ or } \frac{8DJ}{L^2}$$

which are equated moments taken about the point of intersection of the vertical center line between trucks and the neutral axis of the center sills. The uniform load is then assumed to be acting over the beam from end to end with the beam fulfilling the conditions of a simple beam with two supported free ends. This will give curves of the form as shown in 8, 9, 10 and 11, since R must be taken for both pulling and buffing. The vertical ordinates of the bending moment curves as drawn by this latter approximation will not be as large as if the more exact method had been used. The effect of this will be to cause the bending moment peak over the center plate to be slightly less and at the center of the car to be slightly greater in the curve 12, which represents the condition for buffing shocks from under hung draft gear combined with the vertical lading. The effect of this approximation upon curve 14, which represents the condition in which the pulling effects for the same draft gear hanging are combined with those of the vertical lading, is just the reverse of that for curve 12. The effects noticeable in curves 13 and 15, which are respectively similar curves for the overhung draft gear or rather draft gears so placed that the resultant end shock is above the neutral axis, are that 13 is affected the same as 14 and 15 the same as 12, which is practically a reversal of the whole condition as might be inferred from the end shocks acting on opposite sides of the neutral axis.

For the purpose of studying any car it is necessary to first





CENTER AND SIDE SILL SECTIONS OF VARIOUS STEEL PASSENGER CARS.

The numbers correspond to those given in the table of data (Table 1) on page 457, December number.

know the disposition of the end shock and then three of the bending moment curves, 7, 12 and 13, or 7, 14 and 15, will tell all that is of import for underframe design. A combination of these three curves should be made in which the maximum ordinate for each abscissal point be chosen. This will give the moment that must be provided for in the design. These ordinates should not be combined algebraically as it is the single maximum which is required. Thus considering 7, 12 and 13, over the truck centers the moment from 12 should be chosen and for the center, the ordinate from 13.

This curve when drawn would seem to indicate a severe shearing point between P_3 and P_4, but such is not actually the case. This is due to the fact that it is not possible to have pulling and buffing strains simultaneously, yet they may occur in consecutive intervals of time and hence must be provided for. The character of this maximum strain must be considered for if tension, to it should be added the strains due to the axial component of the pulling, and if compression, it is necessary to include the unit compressive stress due to buffing.

There are many deductions that may be drawn from an inspection of these three necessary curves. Probably the most noteworthy is that from 12. It is seen that the moment over the center plate is severe whilst in the center of the car the moments due to end buffing shocks and vertical lading oppose each other, and with a sufficiently strong shock may reduce the resultant bending moment to zero. Investigation of 13 in comparison with 7 and 12 show that the moment over the center plate is decreased and in the center of the car increased for pulling loads. This shows the advantage of underhung resultant end shock over the overhung as the center bending moment is increased a smaller amount for the former than it would be for the latter. This is at the point where deflection is most troublesome.

The dotted lines in curves 5, 6 and 7 are introduced to illustrate how the central bending moment is reduced by removing the cantilever at P_4 and making the side girder sufficiently strong to carry all the load to P_3. This action is not quite as illustrated since P_3 is increased and hence the slope is somewhat sharper than shown by the dotted lines, but still falling within the full line.

These curves show that it is possible to place the intermediate cantilevers so that the moments over the center plate and at the center of the car are approximately equal for the maximum conditions. The use of additional cover plates in these regions of greatest stress may be necessary. This can be told graphically from the bending moment diagram by considering the moment a measure of the required section modulus which follows from the relation

$$\frac{I}{C} = \frac{M}{S}$$

The method of investigating an underframe by curves tells more than an elaborate mathematical treatment as it shows to the designer the whole stage of necessities at a glance. The value of the analytical treatment is found when it is desired to check some special sections for greatest stress to provide against possible error.

ANALYTICAL ANALYSIS.

All the special laws for the solution of beams are based upon the general principle that, "the bending moment at any section is equal to the moment of the reaction about that section minus the sum of the moments of the loads on the left of that section also about the section." For any beam loaded in a complex manner it is much simpler to solve for the bending moment according to this principle than to seek for suitable formulæ in handbooks covering such lading.

The following formulæ are based upon the same diagram (Fig. 11) as used for the graphical analysis.

From the average weights per foot on side and center sills as found under each heading we shall use those for express coach service as follows, in pounds per foot:

Total uniform side sill load = 830

Total uniform center sill load = 550

The weight of vestibule has been taken as 5,400 pounds and the end shock at 150,000 pounds pulling and 500,000 pounds buffing.

The loads with their arms and the bending moments are then as given in the table.

+ ↑↓ −	Forces in pounds.		Arm to section in feet.	Bending moment in foot pounds.
+	Reaction	$P_1+P_2+P_3+P_4+(x+a+b)\,550$	x	$P_1x+P_2x+P_3x+P_4x+550\,(x+a+b)x$
—	Platform end sill	P_1	$x+a+b$	$-P_1x-P_1a-P_1b$
—	Body end sill	P_2	$x+b$	$-P_2x-P_2b$
—	1st Inter-Cantilerer	P_3	$x-c$	$-P_3x+P_3c$
—	2nd Inter-Cantilerer	P_4	$x-c-d$	$-P_4x+P_4c+P_4d$
—	Uniform centre sill load	$550\,(x+a+b)$	$\frac{x+a+b}{2}$	$-275\,(x+a+b)^2$ *
—	End shock Load pulling	150,000	$J+\Delta$	$-150{,}000\,(J+\Delta) = -\frac{w}{8}(x+a+b)^2$ *

* Combined center sill load and end shock =

$$-\left(275+\frac{w}{8}\right)(x+a+b)^2 = -\left(\frac{2200+w}{8}\right)(x+a+b)^2$$

The total bending moment Mx is thus: =

$$550\,x\,(x+a+b) - P_1a - (P_1+P_2)\,b + (P_3+P_4)\,c + P_4d - \left(\frac{2200+w}{8}\right)(x+a+b)^2$$

the values of $P_1 = 2700$

$$P_2 = 2700 + 830\,\frac{b+c}{2}$$

$$P_3 = 830\,\frac{b+c+d}{2}$$

$$P_4 = 830\,\frac{d+e}{2}$$

substituted in the above, and the equation $15{,}000\,(J+\triangle) = \frac{w}{8}(x+a+b)^2$ solved for w and its value also substituted, give as a result:

$$Mx = \left(275-\frac{w}{8}\right)x^2 - \frac{w}{4}(a+b)\,x - \left(275+\frac{w}{8}\right)a^2 - \left(690+\frac{w}{6}\right)b^2 + 415\,(c+d)^2 + 415e\,(c+d) - \left(550+\frac{w}{4}\right)ab - 2700\,(a+2b)$$

There is but one variable in this expression as a, b, c, d, e and w are known from the design.

This bending moment table and the result show various relations between the loads and arms of the moments which we have touched upon in the discussion. The combination of the uniform center sill load and end shock into the form

$$\left(\frac{550}{2}+\frac{w}{8}\right)\left(x+a+b\right)^2$$

illustrates the ease with which the uniform center sill loading can simply be increased to provide for these end shocks. The direct axial stresses in the backbone should not be neglected in finding the required section modulus and area.

The value 150,000 pounds for pulling has been here used because the section chosen for x is near the center of the beam and the curves show this case to give the maximum moment in this region.

Now x can be taken at the other point of extreme moment, namely over the truck center. This will affect the table by reducing the reaction and all other load moments by everything to the right of the center plate. When it comes down to the last moment it becomes necessary to use the value of 500,000 $(H+\triangle)$ instead of 150,000 $(J+\triangle)$ for the minimum bending moment.

The formula as found is applicable to but the type of car under consideration and loaded as shown. The idea, in solving it, is simply to emphasize the procedure which should be followed for any particular class or form and to illustrate a feature, which is a consequence of the resultant equation, necessary to a consideration of interchangeability as found in our previous article.

For any car under process of design the formula will not look so formidable since there is but one unknown variable in the equation. The terms in a, b, c, d, e and w are known from the design so that there may be written as the final result

$$Mx = \delta\ (x^2) \pm f\ (x) \pm K$$

Putting this into words would mean that "the bending moment at any section between the truck centers is a certain function of x^2, plus or minus a different function of x, plus or minus a constant.

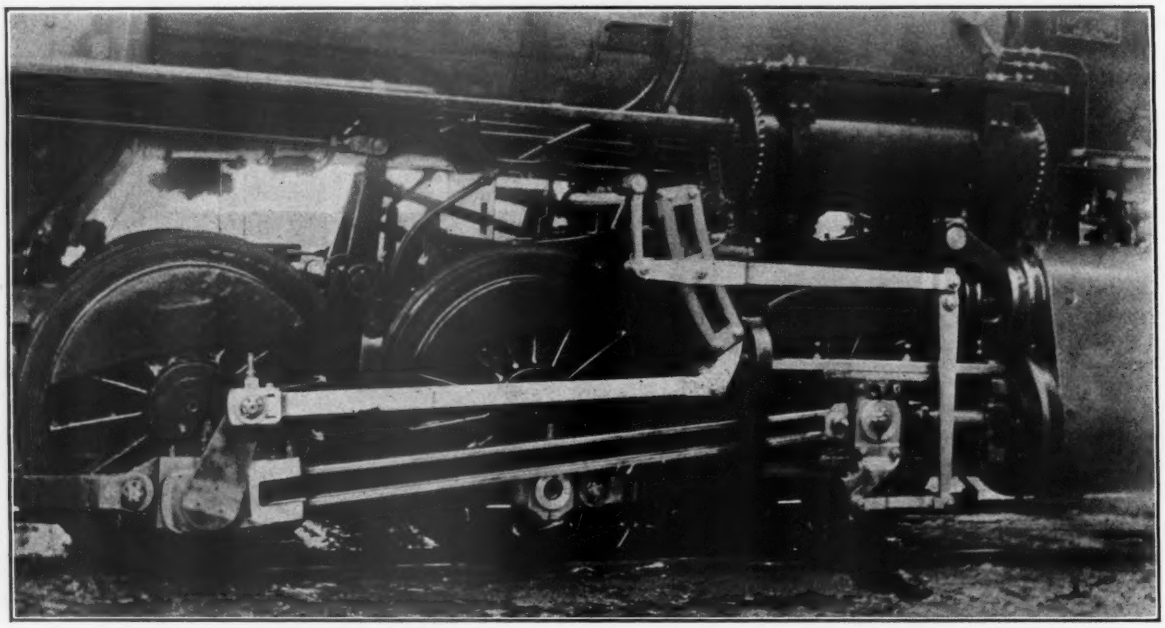
This can again be changed into the form

$$\mathbf{Mx} = K_1\ [(x \pm K_2)^2 \pm K_3]$$

which when divided by the stress will give a value of section modulus. Now knowing the section modulus furnished for a given type of underframe, this equation can be solved for the maximum length between truck centers, possible with a given underframe, to keep within the stress limits allowable. Or, again, it is possible to evaluate the equation for different values of $x = \frac{L}{2}$, when Mx is a maximum, and find a series of corresponding values of M. These values of M when combined with the permissible stress will give the requisite value of modulus of resistance.

Thus an underframe type may be chosen for all classes of service and cars of different lengths built upon it by changing the section modulus to suit the moments. An increase or decrease in the thickness of cover plates used or the weight of section for beams will usually be all that is demanded.

The work of mathematically designing the varying cars of unequal lengths and similar lading found in a complete equipment is measurably simplified by the adoption of this expedient. Throughout all the calculations for the stresses occasioned by the bending moments of both vertical and horizontal loads it should be carefully borne in mind that the direct axial stresses, tensile and compressive, have an effect in reducing the permissible straining of the girders by these moment loads. This is so frequently overlooked and not considered that it is deemed advisable to make it of particular note.



WALSCHAERT VALVE GEAR APPLIED TO CONSOLIDATION LOCOMOTIVE— CANADIAN PACIFIC RAILWAY.

WALSCHAERT VALVE GEAR.

CANADIAN PACIFIC RAILWAY.

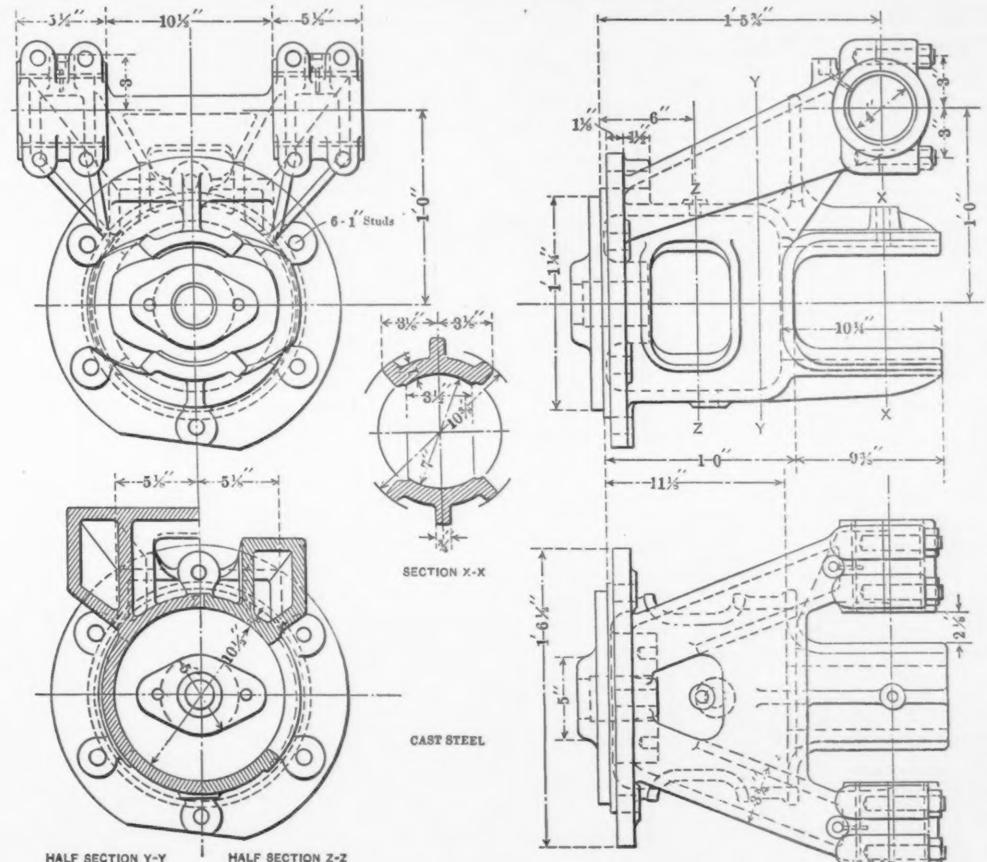
One of the prime essentials of any good valve gear is that the motion of the valve, when once set, shall be exact and invariable. This necessarily requires a substantial and rigid construction throughout, parts which are light but stiff, so they will not spring and bind; hardened bushings and pins to prevent wear and lost motion; ample bearing surface to allow efficient lubrication, and secure fastening of all carrying members to a practically rigid support. Experience has shown that these conditions are more easily fulfilled with a gear of the Walschaert type than with the Stephenson motion, and that locomotives so equipped remain square much longer. It will be noticed, however, that all of the recent designs of Walschaert gear are considerably heavier and more substantial in every way than were the earliest attempts, and it is now doubtful if a well designed Walschaert gear weighs less than a Stephenson motion for the same class of engine. This would indicate that in the earlier designs too much confidence was placed in the type alone and the parts were not made sufficiently stiff and strong to fulfil the duties of a successful motion.

Recognizing these conditions, the mechanical department of the Canadian Pacific Railway has recently designed a motion of this type, which is to be fitted to their standard class M-4 consolidation locomotives. (AMERICAN ENGINEER, May, 1906, p. 161.) It is so excellent an example of what a good valve motion should be, in which the possibility of the springing, sagging, or otherwise getting out of position of any part has been carefully avoided, that we devote considerable space to showing the detail parts.

This gear has been designed to suit the same cylinders and other parts that are used for the same class of engines having Stephenson motion so that at any time should it be desired, the Walschaert gear can be applied to the present engines without having to change any of the large and important existing parts.

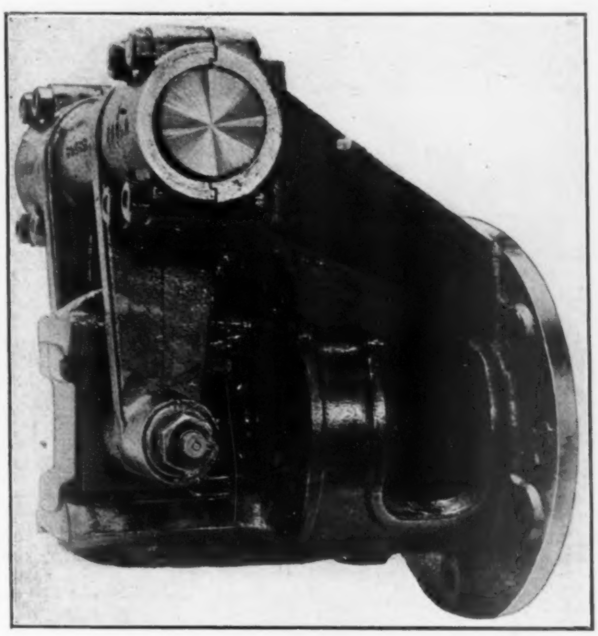
Ten new engines built and put into service during March and April were equipped with the motion and up to the present have given satisfactory results, and both the enginemen and those in charge of these engines speak very favorably of it.

The connection between the combination lever and the valve stem has been given careful attention to provide that the valve shall at all times move exactly in a horizontal line. This construction consists of a casting which forms, in one piece, the valve chamber head, a guide for the valve stem crosshead and



VALVE CHAMBER HEAD AND ROCKER BEARING, WALSCHAERT VALVE GEAR—C. P. R.

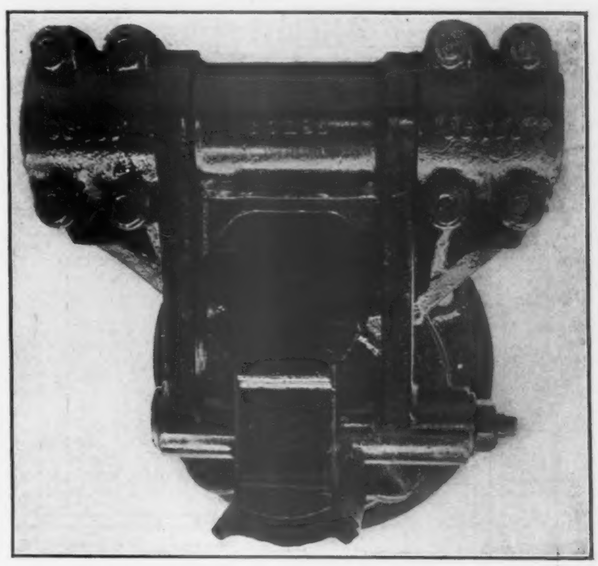
a bearing for the rocker arm which carries the weight of the combination lever and its connecting parts. This rocker has two downwardly projecting arms connecting to a block or small crosshead working in guides formed within the valve stem crosshead. The pin connecting the arms with the sliding block has an extension on the outside to which the combination lever



VALVE CHAMBER HEAD AND CONNECTIONS.

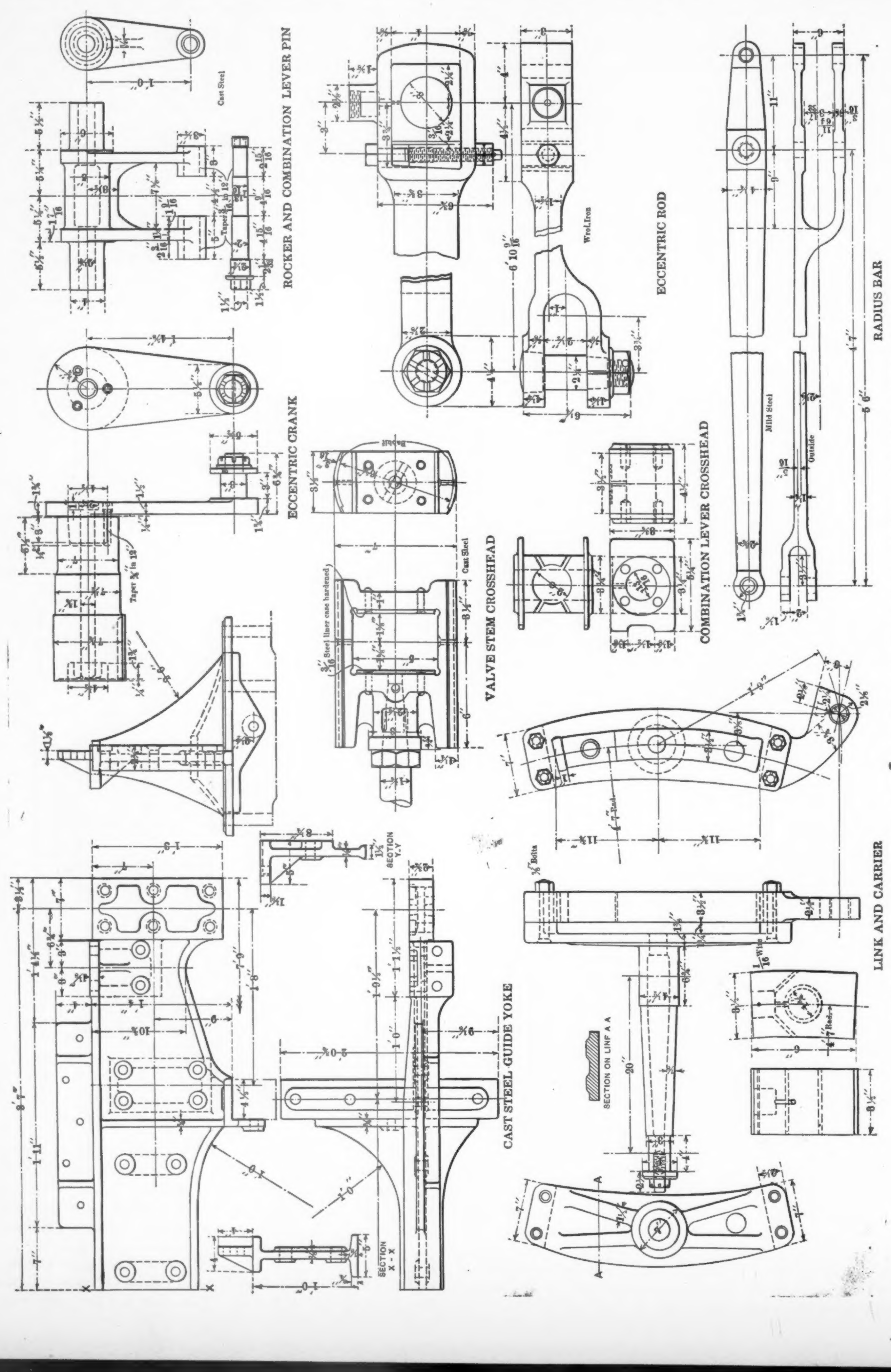
is connected. This construction thus provides a perfectly rigid support for the valve stem cross head and relieves it of the duty of carrying the weight of any of the parts of the valve gear. It also places the whole construction in a position where it will not interfere with the removal of other parts such as guides, front frame rail, spring rigging, etc.

The support of the link, reversing shaft and radius bar, which combined with their bearings, form a mass of considerable weight and must be supported some distance outside of the frames, has also been given careful attention to provide for perfect rigidity. These parts are carried by a deep cast steel guide yoke, having a bearing of more than 2 ft. in length on the main frame and a



ROCKER ARM, VALVE STEM CROSSHEAD AND SUPPORT.

depth of 16 in. over the frame. It is also provided with ample webs and flanges and liberal bearing surface at all points of connection with other parts. The link itself is of case hardened wrought iron in one piece and is bolted to a cast steel link carrier, which includes a shaft carried in two bearings placed 20 in. apart and secured to the guide yoke. The reverse shaft extends across the engine and is carried in two bearings secured just inside of the outer link bearing. This shaft has two cast steel



DETAILS OF WALSCHAERT VALVE GEAR AS APPLIED TO CONSOLIDATION LOCOMOTIVE—CANADIAN PACIFIC RAILWAY.

arms curved to clear the link and connect to the end of the radius bar back of the link. It also has a downwardly extending arm near the center which is connected to an arm on a reverse shaft, located in the standard position for the Stephenson link motion, which carries the counterbalance spring and connects to the reverse lever.

The radius bar, shown in one of the illustrations, is provided with a fork on either end, the forward one spanning the top of the combination lever and the back one spanning the link and link block. The eccentric rod, which is 6 ft. 10 9/16 in. long between centers is pinned to the extension on the link and has a split brass bearing at its connection with the eccentric crank. A wedge block is provided for taking up the wear in the brass.

The eccentric crank connection to the main pin consists of a boss 4½ in. in diameter and 3 in. high, which has a taper and draw fit in a recess in the main pin and is drawn up by a bolt passing through the center of the pin. The crank is set to a templet and three dowel holes are drilled and tapped and dowel pins screwed in, their heads being countersunk. This construction makes the eccentric crank practically an integral part of the pin and no provision is made for removing it under ordinary circumstances, since strap end main and side rods are used on the main pin.

The bearings throughout the gear are bushed with cast iron bushings hardened by the Meyers process and all pins are case hardened. The pins in practically all cases have a taper fit and projecting dowels. Single nuts slotted for split keys are used throughout. The provision for lubrication is very complete, as is shown in the illustrations of the details.

The setting of the gear provides for the eccentric crank to follow the pin and to have a throw of 16 in. When the pin is at the top quarter the eccentric pin is ⅝ in. below the horizontal center line. The parts are so proportioned as to give a valve travel of 6 in.

The following detailed statement of the weights of the Stephenson and Walschaert gears as applied to the same locomotives indicates the correctness of the opinion advanced above and shows the Walschaert gear to be 141 lbs. heavier:

WEIGHT COMPARISON.

STEPHENSON VALVE MOTION.

Part.	Weight.	No. per Eng.	Total Weight per Eng.
Guide Yoke Bracket	190 lbs.	2	380 lbs.
Guide Yoke	1,120 "	1	1,120 "
Steam Chest Cover	120 "	2	240 "
Rocker Box	127 "	2	254 "
Rocker	163 "	2	326 "
Transmission Bar	207 "	2	414 "
Link	160 "	2	320 "
Transmission Bar Hanger	40 "	2	80 "
Link Lifter	22 "	4	88 "
Reverse Shaft and Arm	300 "	1	300 "
Eccentric Rods	50 "	4	200 "
Eccentric Straps	202 "	4	808 "
Eccentrics	193 "	4	772 "
Crank Pin	280 "	2	560 "
Total			5,862 "

WALSCHAERT VALVE MOTION.

Part.	Weight.	No. per Eng.	Total Weight per Eng.
Guide Yoke Bracket	700 lbs.	1	700 lbs.
Guide Yoke	210 "	2	420 "
Steam Chest Cover	450 "	2	900 "
Rocker	150 "	2	300 "
Valve Stem Guide	50 "	2	100 "
Link	345 "	2	690 "
Outside Link Bearing	100 "	2	200 "
Inside Link Bearing	65 "	2	130 "
Lifting Shaft Bearing	100 "	2	200 "
Lifting Shaft	320 "	1	320 "
Lifting Arm	60 "	2	120 "
Lifting Arm (center)	110 "	1	110 "
Link Lifter and Pin	32 "	2	64 "
Reach Rod Intermediate	55 "	1	55 "
Reverse Shaft and Arms	250 "	1	250 "
Eccentric Rod	165 "	2	330 "
Radius Rod and Pin	120 "	2	240 "
Combination Lever	48 "	2	96 "
Union Link	23 "	2	46 "
Crosshead Arm	50 "	2	100 "
Crank Pin Complete	316 "	2	632 "
Total			6,003 "

Excess weight of Walschaert gear = 141 lbs.

SIGNAL TESTS.—During the month of October 2,245 surprise signal tests were made on the Pennsylvania Railroad, of which 98.8 per cent.. showed absolute perfection. Of the remaining 1.2 per cent. all trains were stopped, but had passed the signals by a few feet.

HEAVY SWITCHING LOCOMOTIVES FOR CLASSIFICATION YARDS.

CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RAILROAD.

The American Locomotive Company is delivering from its Brooks Works two very powerful locomotives of the 0-10-0 type, designed for service in the classification yards of the Big Four Railroad. These engines are practically duplicates of those which were put into service on the Lake Shore & Michigan Southern Railroad about two years ago. (See AMERICAN ENGINEER, Sept., 1905, page 330.) The slight changes which have been made have increased the weight to 274,000 lbs., which gives a weight per driving axle of 54,800 lbs.

These locomotives were designed especially for handling the cars over the hump and are capable of pushing 3,000 tons on a .5 per cent. grade and 1,800 tons on a 1 per cent. grade. The 24 x 28 in. cylinders with 210 lbs. steam pressure and 52 in. drivers, give a tractive effort of 55,260 lbs., and as it is necessary for these engines to work at very low speeds and without slipping, a factor of adhesion of nearly 5 is used. The different boiler ratios are of about the average for freight locomotives, but the ratio of total heating surface to volume of cylinders is much larger than usual, because of the necessity of working at practically full stroke all the time.

Reference can be made to the drawings accompanying the article mentioned above on the Lake Shore & Michigan Southern engine for the details of this design and the general dimensions, weights and ratios are shown in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Pushing in Yards
Fuel	Bit. coal
Tractive effort	55,360 lbs.
Weight in working order	274,000 lbs.
Weight on drivers	274,000 lbs.
Weight of engine and tender in working order	423,900 lbs.
Wheel base, driving	19 ft.
Wheel base, total	19 ft.
Wheel base, engine and tender	56 ft. 8½ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.94
Total weight ÷ tractive effort	4.94
Tractive effort x diam. drivers ÷ heating surface	625.00
Total heating surface ÷ grate area	81.50
Firebox heating surface ÷ total heating surface, per cent	4.10
Weight on drivers ÷ total heating surface	59.60
Volume both cylinders, cu. ft	14.70
Total heating surface ÷ vol. cylinders	314.00
Grate area ÷ vol. cylinders	3.85
CYLINDERS.	
Kind	Simple
Diameter and stroke	24 x 28 in.
Piston rod, diam.	4¼ in.
VALVES.	
Kind	Piston
Diameter	12 in.
Greatest travel	5⅜ in.
Outside lap	1 in.
Inside clearance	0 in.
Lead in full gear	¼ in.
WHEELS.	
Driving, diameter over tires	52 in.
Driving, thickness of tires	4 in.
Driving journals, main, diameter and length	10½ x 12 in.
Driving journals, others, diameter and length	9½ x 12 in.
BOILER.	
Style	Wagon top
Working pressure	210 lbs.
Outside diameter of first ring	80 1/16 in.
Firebox, length and width	108⅛ x 75¼ in.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ in.
Tubes, number and outside diameter	446—2 in.
Tubes, length	19 ft.
Heating surface, tubes	4412.7 sq. ft.
Heating surface, firebox	188.5 sq. ft.
Heating surface, total	4601.2 sq. ft.
Grate area	56.5 sq. ft.
Smokestack, diameter	20 and 24 in.
Smokestack, height above rail	14 ft. 10½ in.
Air pump	W. A. B. 11 in.
Air reservoir, number	2
Air reservoir, size	18½ x 120 in.
TENDER.	
Tank	Water Bottom
Frame	13 in. channel
Water capacity	7500 gals.
Coal capacity	12 tons

PREMIUMS TO EMPLOYEES FOR PATENTS.—A correspondent to the *Times Engineering Supplement* states that the German government railways have a fund for payment of premiums to employees who invent any appliance which may be useful in railway practice, and that during the last traffic year $3,700 was paid on that account to employees.

(Established 1832).

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Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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When a Subscriber changes his address *he should notify this office at once, so that the paper may be sent to the proper destination.*

CONTENTS

HANDLING ENGINE SUPPLIES.

The handling of engine supplies has not been considered as seriously as it should be in this country, because the possible savings appear small and it is hard to realize that much better service can be obtained in this direction by proper supervision at a very much less expense than it is now costing the average railroad. We have just received word, as we are about to go to press, that the article in this issue, which so clearly shows the possibilities in this direction, will be followed by two articles presenting detail methods, forms of accounting and drawings of standard equipment.

WALSCHAERT VALVE GEAR.

At its introduction, the claim that the Walschaert type of valve gear would save considerable weight over the Stephenson motion was advanced as one of the principal advantages of the gear and in the early designs this was a fact. Longer experience, however, showed the necessity of using stiffer and more rigid supports, which, taken in connection with the usual necessity of a change in the location of the piston valve chamber, making the cylinder casting of greater weight, has reversed these conditions and practically all locomotives now fitted with the Walschaert gear will weigh more than the same engines designed for and fitted with the Stephenson motion. The present widespread popularity of this type of valve motion shows, however, how little this matter of weight is actually considered in comparison with the other advantages of the gear. An example of this is shown in a design illustrated in this issue, which is being applied by the Canadian Pacific Railway. In this it is evident that the matter of weight, while carefully considered, was of secondary importance and the main object was to get a valve motion which would perfectly perform its functions even if it was found necessary to use extra parts and greater weight.

YOUNG MEN AND POSITIONS OF RESPONSIBILITY.

A superintendent of motive power, who has made a special study of the problem of organization and has under him a strong and loyal organization which is constantly developing leaders from among the younger men, has tried to impress the following thought on his subordinates:

"One of the common faults in those who have the management of large forces is that of not thoroughly understanding the elementary fact that if we desire to keep our positions as foremen and executives it is necessary to keep our forces young. To make this clear it may be truly said that if we keep our forces young it does not matter how old we may be ourselves, we will be practically sure of retaining our positions."

"It should be distinctly understood that men are capable of accepting positions of responsibility when they are very young. As an illustration we might say that when a man is twenty-one or twenty-two he should be advanced to a position of responsibility where it is necessary for him to handle a number of men. The common fault lies in the fact that we usually consider those under us young if they are slightly younger than ourselves."

"Following out this line of thought, it is easy to see that a man of seventy-five would consider a man young who was seventy-four and would quite likely only promote those who were near his own age. Therein lies the mistake. The man of seventy-five should realize that in order to have an efficient organization he should promote men of twenty-one or twenty-two years of age to positions of responsibility."

STEEL FREIGHT CAR REPAIRS.

About 55 per cent. of the freight cars belonging to the Pittsburgh & Lake Erie Railroad are of steel construction. For a number of years the repair work on steel cars was done in the open and with very few special facilities. During the greater part of this time the rebuilding of the locomotive and car shops at McKees Rocks was under consideration and when the plans for the car department, which was the last to be completed, were finally adopted the railroad had not only a very extensive experience in the repair of this type of car to guide it, but it had also been able to give the question very careful consideration and study in order to make the facilities for handling this class of work as complete and effective as possible. In view of these facts the first article in this issue will prove especially valuable to those who are interested in this work. Except for the building, which is of rather expensive construction, the facilities are comparatively simple and not nearly as costly as might be expected. The method of carrying a complete supply of all parts, so that damaged parts can be quickly replaced with new ones in order to get the car back into service with the least possible delay, is important. The use of

overhead cranes simplifies the organization, as the men can be divided up into gangs of two men each instead of four or five, or possibly more, as is necessary where cranes are not provided.

Not the least interesting part of the work of this department is the repainting of the cars with spraying machines. It is doubtful whether any road has better painted cars, and the spraying machine as used on the Pittsburgh & Lake Erie Railroad has certainly given a splendid account of itself during the time in which it has been used, which covers a period of several years. It is surprising that the spraying machine is not more extensively used on other roads.

PRACTICAL WORK IN CONNECTION WITH COLLEGE TRAINING.

Some provision should be made in the engineering courses of our colleges and universities to have the students receive training in practical work, either previous to or at the same time that they are receiving their college training. By practical work we do not mean work in the college workshop but in connection with some industrial or engineering concern. It is surely wrong to graduate a man from college and turn him out into the world with an engineer's degree without his having done any practical work at all. It is even a more serious matter to give such a man a position on the teaching staff, placing him in charge of other students.

Professor H. Wade Hibbard, in charge of the department of railway mechanical engineering of Cornell University, has, ever since he took up college work, tried to impress the engineering students, with whom he came in contact, with the importance of working in the shops during summer vacations, in order that they might have a better understanding and appreciation of their work in college and be better fitted to take responsible positions when they were graduated.

Professor Hibbard has kindly furnished us with the names of the members of the class who are now taking his major course in railroad mechanical engineering, consisting of four lectures a week during the senior year; also data as to just what practical experience each of these young men has had, as far as he has been able to ascertain.

Ninety-three students are taking this work up and the previous experience of all but twelve of them had been found when the data was sent to us. Of the remaining eighty-one, eleven, or about 13½ per cent., have apparently had no business experience at all. Four have worked during summer vacations but in lines which were not allied to engineering work. Of the remaining sixty-six all have had experience, more or less, in work which was in some way allied to engineering of some kind, including work in railroad and manufacturing shops, automobile repairing, mining work, the manufacturing, repairing and testing of electrical machines, etc. In the following statement, showing just how many months of experience each boy has had, three months have been allowed for a summer vacation.

A number of the young men have had considerable experience in other lines, which is of course not included in this statement. The data for three men was a little indefinite and could not be included. One of these worked in the factory of a lead works and had had some experience in the drafting and advertising department of an electric company. Another had spent several summers in automobile garages and repair shops. Another had been engaged in electrical testing and electric railway installation. Sixteen had between one and three months' experience; sixteen five or six months; thirteen from seven to nine months; six from ten to twelve months; seven from fourteen to eighteen months; one, twenty-one months; one, thirty-three months; one, forty-three months; one, fifty-four months, and another five years in addition to several summer vacations.

This indicates a gratifying condition at Cornell and the same thing is possibly true at a few other institutions where members of the faculty have realized the importance of urging the students to spend their summer vacations in this way. It is to be regretted that more college professors do not realize the importance of doing this.

GRAND TRUNK APPRENTICE SYSTEM.

The Grand Trunk Railway System has had an efficient apprentice system in force in its shops for several years with very satisfactory results. It includes a thorough shop training and a course in mechanical drawing, simple mathematics and applied mechanics. At the present time the road has 233 apprentices.

Entrance Requirements.—The applicant must be in good health, free from bodily defects and not less than 15, nor more than 18 years of age. He must file an application with the local master mechanic or general foreman, giving his age, the grade to which he had advanced before leaving school and the positions in which he had been employed since that time. He is then required to undergo a medical examination by the railroad company's resident medical officer. If this proves satisfactory he is given an examination in the master mechanic's or general foreman's office, which is conducted either by the chief clerk or some one specially appointed for that purpose. It includes a test in eyesight and reading, in which the applicant must be able to read extracts from the instructions at the end of the employees' time table (set in seven point or minion type), standing 30 inches from it. His hearing and spelling are tested by writing a letter from dictation, applying for employment at the shops. He must also be able to solve correctly such examples as the following: Multiply 122,983,672 by 527,001 and divide 723,643,978 by 365.

If the applicant passes this examination satisfactorily he is required to copy the written part of it in a record book, so that a complete record of his ability from the day he enters the service will be on file. If he fails to pass the examination he may, if thought advisable, be given a place as a rivet or hammer boy. These boys are taken on probation for one season and if at the end of that time they are still unable to pass the apprentice entrance examination they are dismissed from the service.

Indenture.—The apprentice is indentured for the term of his apprenticeship, the papers being signed by himself and his parent or guardian. He must not join any organization which claims or attempts to control his action or labor in any way. He is required to attend the evening classes for instruction in mechanical drawing and mathematics. If during the first year of his apprenticeship he should prove unfitted, physically or mentally, to acquire the trade, the agreement becomes invalid. The company is allowed to retain five cents per day of his wages, which will be paid to him at the end of his term upon the faithful and full performance of his apprenticeship duties. The company also agrees to pay him a bonus of $25.00 when his apprenticeship has been satisfactorily completed. The schedule of wages for the term of apprenticeship is shown on the indenture papers.

It is claimed that this system has a tendency to keep the apprentice better satisfied and to have him become more interested in his work. It also prevents other concerns from tampering with him and getting him to leave the railroad company after it has given him partial instruction in the trade, and he is beginning to become useful to the company.

Shop Training.—After successfully passing his entrance examinations and signing the indenture papers, the apprentice may be assigned to either the blacksmith shop, boiler shop, or any shop, other than the machine and erecting shop, where he is required to remain for a period varying from six to nine months. He is given a text or instruction book which covers his entire apprenticeship and contains the answers to questions which he will be required to answer correctly before being promoted from one class of work to another. This text book is about 4 x 7 in. in size, has heavy card-board covers and contains about 25 pages. Before being promoted to the machine shop, which is the next step and where he will be started to work on a drilling machine, he must pass an examination as outlined in the text book, and which is partially reproduced in this article. If he cannot pass the examination satisfactorily, he is put back in the shop in which he was working and the next apprentice in line is examined, and if successful is promoted. If the first apprentice cannot pass the examination the next time there is an opportunity for promotion he is dismissed from the service, or is given some minor position outside of the trade.

GRAND TRUNK RAILWAY SYSTEM

MOTIVE POWER DEPARTMENT

EXAMINATION QUESTIONS FOR APPRENTICES

PRACTICAL MECHANICS

APRIL 1907

6
1. Add together 22.4624, 2.3021, .042, 2.3020, 15.04 and 142.2133.
2. Add together 143.5121, 3.651, 10.0002 and 271.28.
3. Add together .06, .0034, .0003, 316.0006 and .000003.

6
4. Subtract 28.9 from 32.96571.
5. Subtract 3.002002 from 4.62.
6. Subtract 32.644632 from 44.

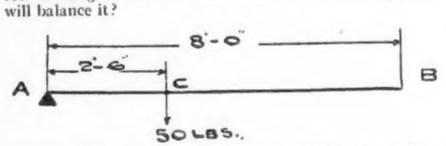
7
7. Multiply 36.2742 by 4154.
8. Multiply .00367 by 6.514.
9. Multiply .00002463 by 86.

8 [4]
10. Divide 482.643 by 265.
11. Divide 8.75061 by 23563.
12. Divide 783.5 by 5206.

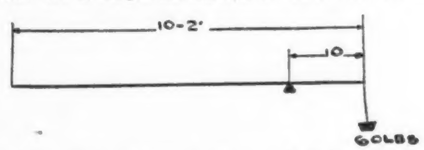
9 [5]
13. Find the circumferences of circles whose diameters are 16", 16.5", 18" and 22".
14. Find the circumferences of circles whose diameters are 64", 75", and 89".

9 [5]
15. Find the areas of circles whose diameters are 23", 25", and 30".
16. Find the areas of circles whose diameters are 35", 39", and 45".

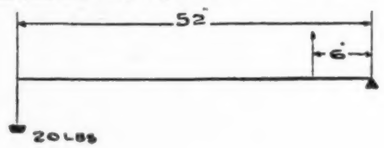
11 [7]
17. In a lever A C B, 8 feet long, supported at A, a weight of 50 lbs. is hung at C, 2' .6" from A. What force applied at B will balance it?



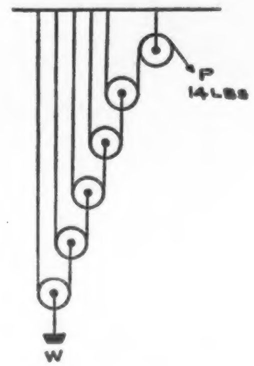
11 [7]
18. What weight will counterbalance a weight of 60 lbs. on a lever 10'. 2" long, when the fulcrum is 10" from the weight?



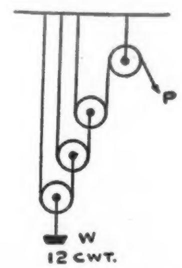
11 [7]
19. A lever 52" long, fulcrum at one end, 20 lbs. weight at the other end, find what weight at 6" from fulcrum will balance it?



11 [7]
20. **In the first system of pulleys, what weight will a power of 14 lbs. support by means of 5 pulleys. Answer in lb.**

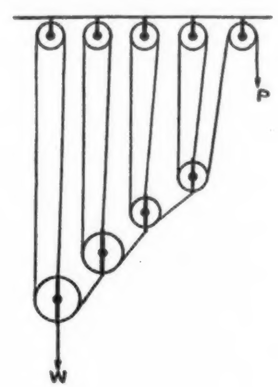


21 **In the first system of pulleys, what power will support a weight of 12 cwt. by means of 3 pulleys. Answer in cwt.**

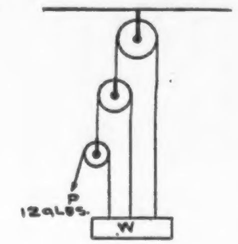


11 [7]
22 **In the second system, what weight will be supported by 4 cwt. with 4 pulleys? Answer in cwts.**

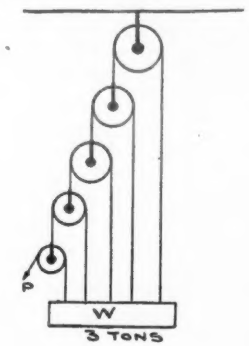
23. **In the second system, what power will be required to balance a weight of 2 tons with 4 pulleys? Answer in cwts.**



[10]
24. **In the third system, what weight will a power of 120 lbs. support with 3 pulleys?**



25. In the third system, what power will balance a weight of 3 tons with 5 pulleys? Answer in cwts.



[11]
26. The piston speed of an engine is 10 feet per second. How many miles will the piston travel in an hour?
27. A railroad train travels 60 miles in one hour. What is the velocity in feet per second?

[10]
28. A body A moves at the rate of 12 feet per second and another B, starting from the same place in the opposite direction at 14 feet per second. Find the distance between them after 10 seconds.
29. The outside diameter of an engine fly wheel is 13'. 9", a point on the rim travels 45,000 feet in 5 minutes. What is the velocity in feet per second?

[10]
30. A train weighs 400 tons, the resistance=10 lbs. per ton. Find work done in drawing it one mile at uniform speed. Answer in foot lbs.
31. A hole is punched through a ½" steel plate. The pressure necessary is 34 tons. Find work done. 1 ton=2240 lbs. Answer in foot lbs.

[10]
32. **A chain 100 feet long, hangs from one end, weight 12 lbs. per foot. How much work is done in coiling it on a drum? Answer in foot lbs.**
33. **In question No 32 how much work is done in raising the lower end of chain to meet the upper end. Answer in foot lbs.**

Rules Governing Examination of First Year Apprentices.

Questions Nos. 1 to 23 are for the above class, although not more than 11 questions are to be attempted. The number of marks for each question in this class is shown thus <11>. It is only necessary to answer one out of Nos. 1, 2 and 3, one out of Nos. 4, 5 and 6, one out of Nos. 7, 8 and 9, one out of Nos. 10, 11 and 12, one out of Nos. 13 and 14, one out of Nos. 15 and 16. Work out 17, 18 and 19, one out of 20 and 21 and one out of 22 and 23.

Rules Governing Examination of all Apprentices Other than First Year.

Questions 10 to 33 are for this class, although not more than 13 questions are to be attempted.

The number of marks for each question in this class is shown thus [11]. Commence at example 10, 11 or 12.

It is only necessary to work one out of 10, 11 and 12, one out of 13 and 14, one out of 15 and 16, work out 17, 18 and 19, one out of 20 and 21, one out of 22 and 23, one out of 24 and 25, one out of 26 and 27, one out of 28 and 29, one out of 30 and 31 and one out of 32 and 33.

GENERAL RULES

Marks will be allotted according to neatness and accuracy, and each set of questions must be pinned together for each pupil.

Always place the number of question close to the working for each problem.

Marks for first year apprentices are shown thus <11>.

Marks for second year apprentices are shown thus [11].

The time allowed for this examination will be two hours.

The following are extracts from the text book:

EXAMINATION FOR PROMOTION OF APPRENTICES FROM OTHER SHOPS TO THE MACHINE SHOP.

Q.—What is the weight of standard shop hammer (machinist's hand)?

A.—Two pounds.

Q.—At what point should hammer be held for efficient service?

A.—At the extreme end of handle.

Q.—What is the length of hammer handle?

A.—Sixteen inches over all.

Q.—How many classes of drills are in general use in this shop?

A.—Two, viz: flat and standard twist drills.

Q.—At what degree is the cutting end of twist drill ground?

A.—Fifty-nine degrees, measuring angle from the centre line of drill.

Q.—Name the speeds for drilling brass, cast iron, wrought iron and steel, different size holes, with carbon steel drills, and air hardened steel drills.

A.—As per table* and as much faster as drill and material will permit.

Q.—Name the speeds for tapping steel, iron and brass, different sizes.

A.—(Table.)*

Q.—What size should holes be drilled for tapping various sizes?

A.—(Table.)*

Q.—What lubricant is used for drilling wrought iron or steel?

A.—A mixture prepared in the shop consisting of oil, soap and water (boiled), or lubricant, as may be furnished.

Q.—What is a center punch used for?

A.—Marking center of holes for drilling and indicating lines on other machine work.

Q.—What is a round nosed chisel used for at drilling machine?

A.—Drawing centers.

Q.—Which side of a belt should be run next to pulley or cone?

A.—Smooth or grain side.

Q.—What are the general rules to be observed regarding cleanliness and care of machines?

A.—All cuttings of different materials are to be kept separate. Machine to be cleaned thoroughly once per week in addition to ordinary daily cleaning, and all working parts kept properly lubricated. Marking or defacing machine in any way to be carefully avoided.

Q.—Explain the reading of an ordinary standard measuring rule.

A.—Apprentice will explain practically from rule.

Q.—How many, and what are the names of the different classes of calipers in general use on drilling machine?

A.—Three: inside, outside, compass or hermaphrodite.

Q.—What tools are necessary for laying off or measuring work at drilling machine?

A.—Inside, outside and compass caliper, dividers, center punch, rule, square and surface gauge.

Q.—What is a jig?

A.—A device for standardizing and duplicating parts, and is a casting or plate fitted with hardened steel bushes which form a guide for drilling, slotting, turning or planing.

Q.—What are its advantages?

A.—Insures perfect accuracy, abolishing the marking off system for machining.

Make drawing of a mogul crank pin, half size; drawing to be inked in.

PROMOTION FROM DRILL TO SHAPER OR PLANER.

Q.—How should work to be planed or shaped be secured?

A.—By means of bolts or clamps, or in a vise, care being taken not to spring or distort the material.

Q.—What are the usual tools in connection with shaper or planer?

A.—Usual standard tools, special tools for special work.

* Omitted for want of space.

Q.—What is the cutting speed per minute for the following classes of material: Steel, wrought iron, cast iron and brass?

A.—Steel and wrought iron, 30 to 35 ft.; cast iron, 30 to 35 ft.; brass, 120 ft.; speed to be exceeded in all cases where possible; reversing speed of planers to be from 100 ft. to 125 ft. per minute.

NOTE.—Planers to be fitted with countershafts to regulate speed for different classes of material.

Q.—What tools are used for setting up work?

A.—Square, surface gauge, and other tools, as described in use on drilling machine.

Make a drawing of mogul big end strap, half size. Drawing to be inked in.

NOTE.—Apprentices will make pencil drawings on paper.

Following the above are questions and answers of the examinations for promotion from the planer or shaper to the lathe, and for promotion from the lathe to the fitting or erecting department. The book also contains similar information concerning the final examination which must be passed before the apprentice can be promoted to the position of journeyman. By having the apprentice pass an examination on a certain class of work, before he takes it up, he gains a general knowledge of it in advance and is encouraged to think more about this work and to observe carefully what is going on about him.

Apprentices in machine work and fitting are required to serve five years; apprentices in other departments are required to serve only four years. These latter must pass the entrance examination and the first of the examinations in the text book, the same as the machinist apprentices. After that they rely for their shop training entirely on the foremen and are only required to take the yearly examinations in drawing and mathematics.

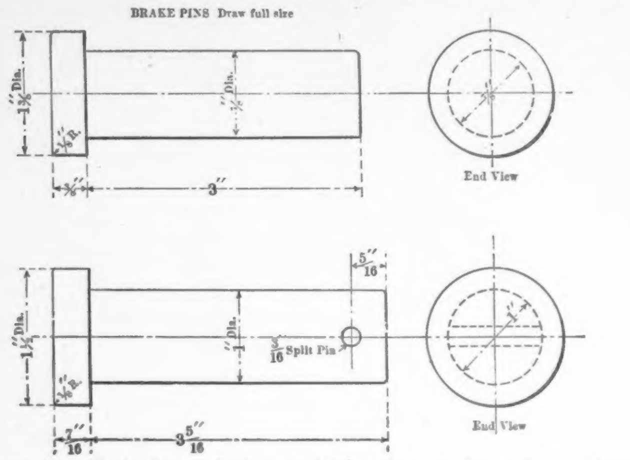
As the shops are practically all operated on a piece-work basis, and the apprentices are pro-rated with the journeymen, it is not thought necessary to have special shop instructors, as it is to the interest of the journeymen to see that the boys understand their work properly.

A record of the shop work of each apprentice is kept, similar to the ones illustrated. These records are made by the chargeman, under whom the boys are working and are examined by the foreman and sent to the master mechanic's office each month.

Class Work.—The apprentices are required to attend evening classes (7.30 to 9.30) twice a week from October to April. These are in charge of competent instructors, and the course includes a thorough training in mechanical drawing, arithmetic and applied mechanics. This instruction, together with the necessary material, except the drawing instruments, which must be provided by the apprentices, is furnished free of charge by the company. The boys are not paid for the time put in in the class room. Apprentices who do not attend the classes regularly, and do not have a good excuse for not doing so, are discharged.

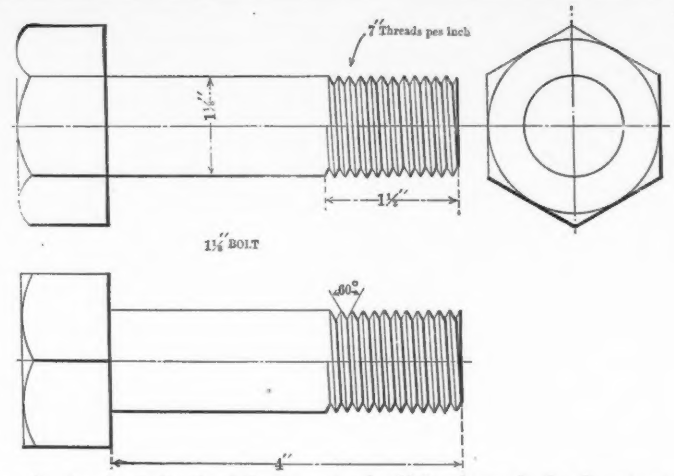
A carefully prepared drawing course has been laid out, which can be covered by the average apprentice in about three years. After that he is asked to draw different parts, making his own rough sketches and working directly from the object, and without special instruction. He is also given practice in making general or assembled drawings. When the apprentice first reports to the class he is given instructions in a blue print pamphlet as to how to go about his work and use his tools. Also information as to the method of laying out his drawing sheet, lettering, figuring, etc. No time is wasted on geometrical exercises. The first part of the course consists almost entirely of redrawing the exercises to a different scale, the subjects treated being such as the apprentice is familiar with in connection with his shop work.

The first exercise is illustrated in Fig. 1. It wll be seen that the apprentice is required to use his compass from the very first, and that he must draw this exercise several times until he becomes somewhat accustomed to the use of his tools. He is also expected to shade the rounded portions, as all drawings which are made in the Grand Trunk drawing office are shaded thus. The second exercise is for a wrought iron link and lever and also requires the use of the compass and dotted or invisible lines; in addition it requires the use of the 45-degree triangle. The third exercise shows three links of a standard chain. The fourth, which is reproduced in Fig. 2, is for a $1\frac{1}{8}$-in. bolt, and in addition to the principles already introduced, calls for the drawing of a hexagon and the drawing of threads. The seventh exercise



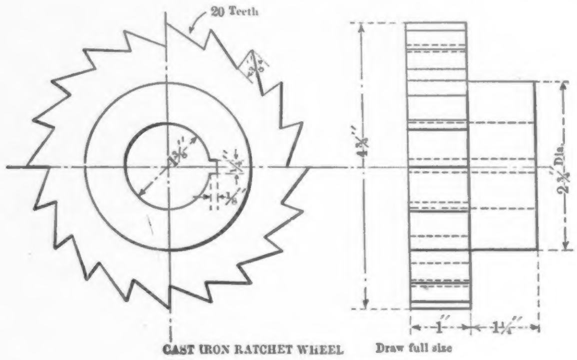
Draw the 7/8" pin first and after completing the two views of same, draw again and even a third one, then proceed with 1" pin, which draw several times.

FIG. I.—FIRST EXERCISE.



In drawing bolts the following rule should be observed: the diameter of bolt being given, thickness of head and also nut will be equal to that diameter, the distance across corners or angles equal to twice the diameter. This is not altogether correct but is done to simplify the drawing of bolts.

FIG. 2.—FOURTH EXERCISE.



CAST IRON RATCHET WHEEL Draw full size

FIG. 3.—SEVENTH EXERCISE.

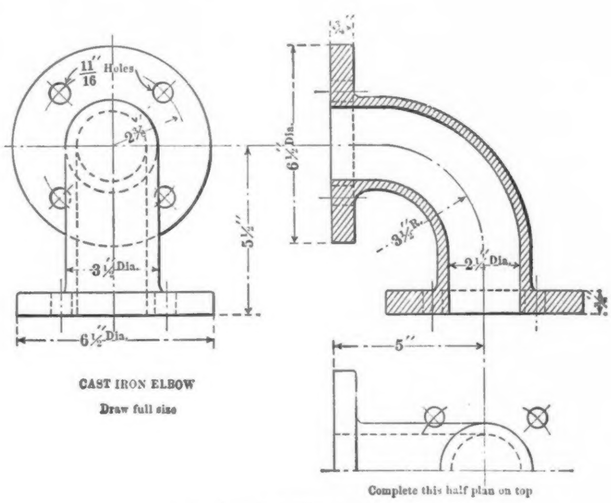
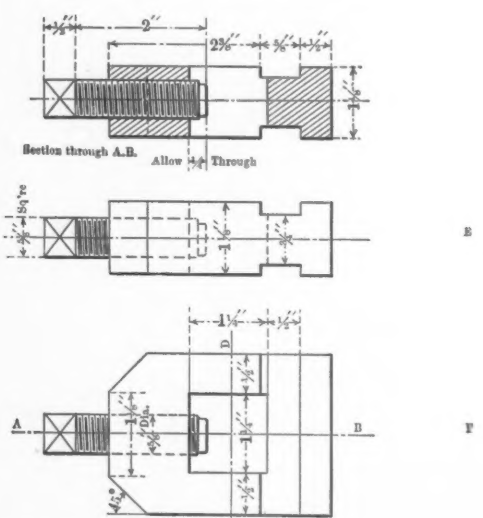


FIG. 4.—TWELFTH EXERCISE.



Draw also end elevation at point "E," looking on top of screw. Show also section at point "F" through "C," "D," the left hand portion being removed.

FIG. 5.—NINETEENTH EXERCISE.

introduces the principle of dividing a circle and is shown in Fig. 3. The eleventh exercise introduces the conventional method of showing threads. The twelfth exercise, shown in Fig. 4, is the first to require sectioning. In the first eighteen exercises the apprentice is not required to introduce any new views. The nineteenth exercise, which is a tool holder for a shaping machine, requires the drawing of two additional views, as shown in Fig. 5. From this point the exercises are varied, some being quite difficult, but with simpler ones intervening, so that the student is encouraged in his work and can realize that he is making progress. The thirty-fourth exercise, which is the last one of this part of the course, is the drawing of a driving box, and is shown in Fig 6.

In connection with the mechanical drawing the student is given a course in practical mechanics. This course is outlined in a little book which has been prepared by Mr. James Powell, the chief draftsman, and with the aid of it the instructor directs this part of the class work. The student is first given problems in simple arithmetic, and as he becomes proficient in this is gradually advanced until, at the end of his apprenticeship, he is expected to have a good working knowledge of the simpler laws of mechanics and the properties of materials. The outline by Mr. Powell has an appendix containing tables of the areas and circumferences of circles and the decimal equivalents of the fractional parts of an inch and of a foot. Also information concerning steam, water and gas pipes and threads for pipes and bolts. A brief history of the locomotive is also given.

In the spring of each year examinations in drawing and mathematics are held over the entire system, in which every apprentice is required to participate. Five sets of questions are prepared, one for the apprentices in each year. The questions for the examinations in mathematics held last spring are reproduced complete. This course had, up to that time, only been in force for about two years and for that reason the questions for the apprentices in the second, third, fourth and fifth years were the same. These questions will give a fair idea of the ground covered in two years time by the course in mathematics. Examinations are held in mechanical drawing at about the same time, the apprentice being required to make two or three pencil drawings in two hours time. The examination questions for the first and fifth year apprentices are reproduced.

The examination papers are all numbered and the boy's name, with the number of his paper, is placed in a sealed envelope, which is sent with the examination papers to the office of the chief draftsman at Montreal, who examines and marks them. To encourage the boys in their studies prizes are offered to those

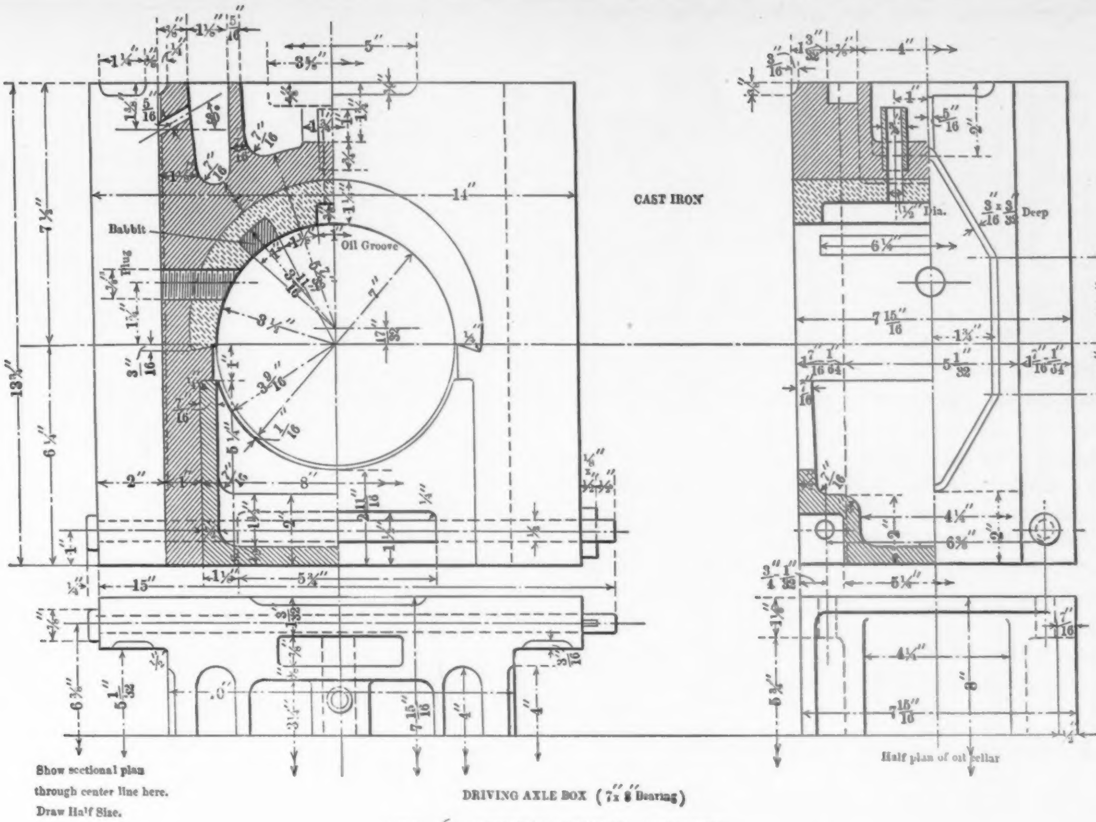
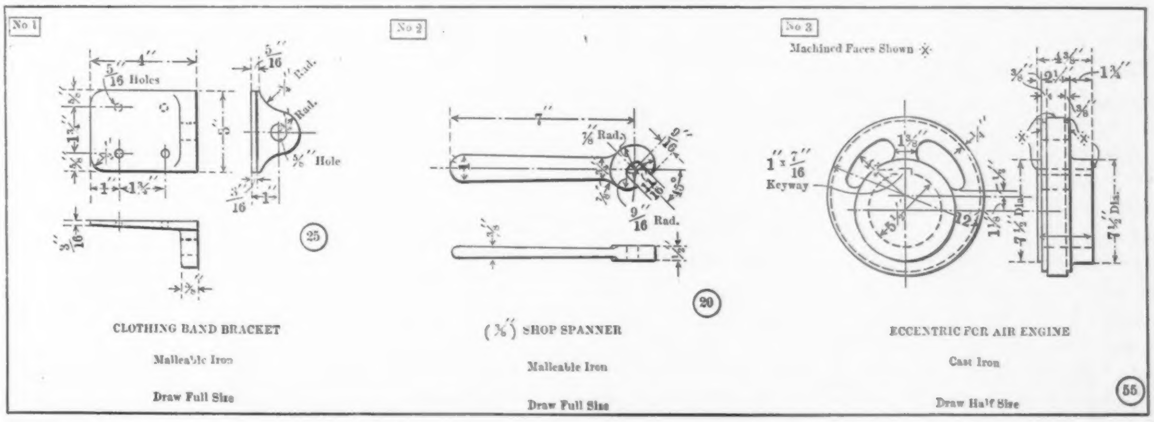


FIG. 6.—THIRTY-FOURTH EXERCISE.



Draw the above as indicated, printing title, notes, etc., in each case. The value attached to each question is shown thus (55). Total number of marks obtainable = 100. Always place the number of the question alongside your work. Do not copy errors.

MECHANICAL DRAWING EXAMINATION. FIRST YEAR APPRENTICES.

who have the best standing in each class at each shop. Special prizes are also given to the apprentices, in each class, having the highest standing on the system. The class obtaining the highest average on the system is also given a special prize. The boys take a great interest in this competition, and there is keen rivalry between the apprentices in each shop and between the various shops. Many of the boys devote considerable time out of class in studying along the lines prescribed in the course, in order to make a more creditable showing at the examinations. The railroad company has two scholarships at McGill University which are open to the apprentices making the best records.

FOREMAN'S APPRENTICE RECORD.

Name	Shop	Month 1905	Workmanship				Conduct				Attendance				REMARKS
			7	14	21	31	7	14	21	31	7	14	21	31	
J. French......	Erecting	January	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	½ day off for funeral
A. McDonald..	"	"	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	
F. Finch.	"	"	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	

Noted:
Master Mechanic.

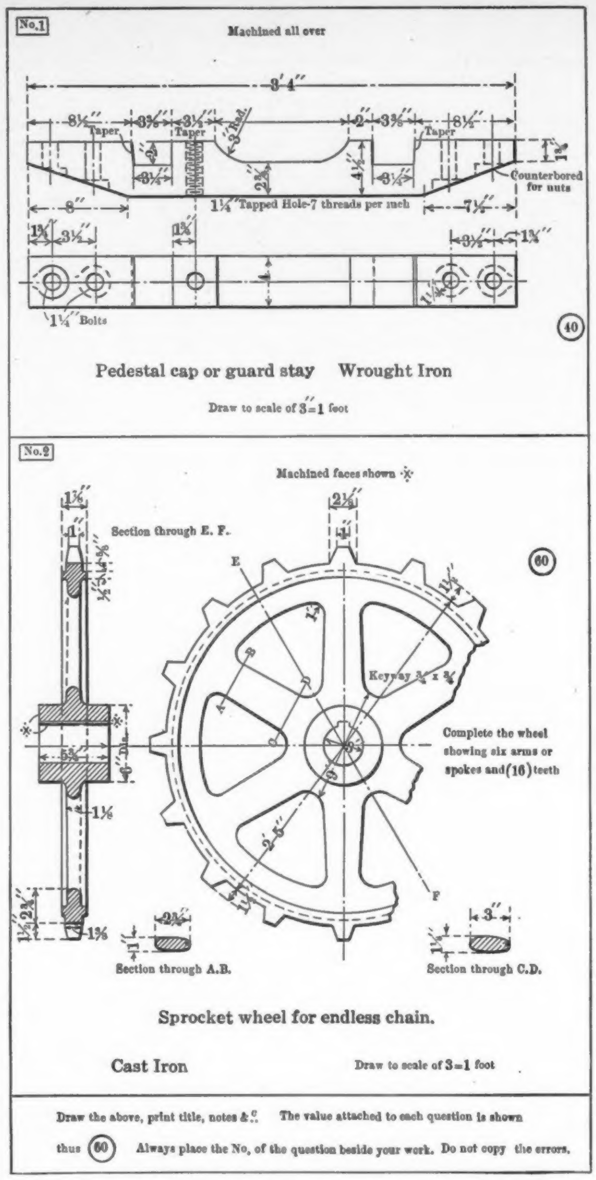
Wages.—The rates are governed by the schedules for each shop which are authorized by the superintendent of motive power.

Results.—The Grand Trunk System has taken a greater or less interest in its apprentices for many years, but just previous to the establishment of the new system a few years ago, as out-

lined above, it had been somewhat neglected, and it was found difficult to get a good class of apprentices and workmen. The difficulty of obtaining good apprentices almost immediately disappeared upon the establishment of the present system. Under the old system, when the entrance requirements were not so rigid, parents would take their boys out of school at 13 and have them work at some other shop for two years, and then have them start to work at 15 in the railroad shops. Now it is necessary for them to keep the boys at school longer in order that they may "make good" when they enter the service of the railroad. In addition to recruiting the force in the shops, and providing the company with a better grade of mechanics, a number of the boys have developed into first-class draftsmen, and have been found to be much more valuable to the company than the average draftsman, who has little or no shop experience.

Graduation.—At the end of his term the apprentice is required to take an examination in shop practice, which is outlined in the text book. If he passes this successfully, and his record in the shop has been satisfactory, he is granted a certificate of apprenticeship, and is given a bonus of $25, in addition to the percentage of his wages which has been held by the company. He is then given journeyman's wages, the rate depending upon his past record.

We are indebted to Mr. W. D. Robb, superintendent of motive power, and Mr. James Powell, chief draftsman, for information.



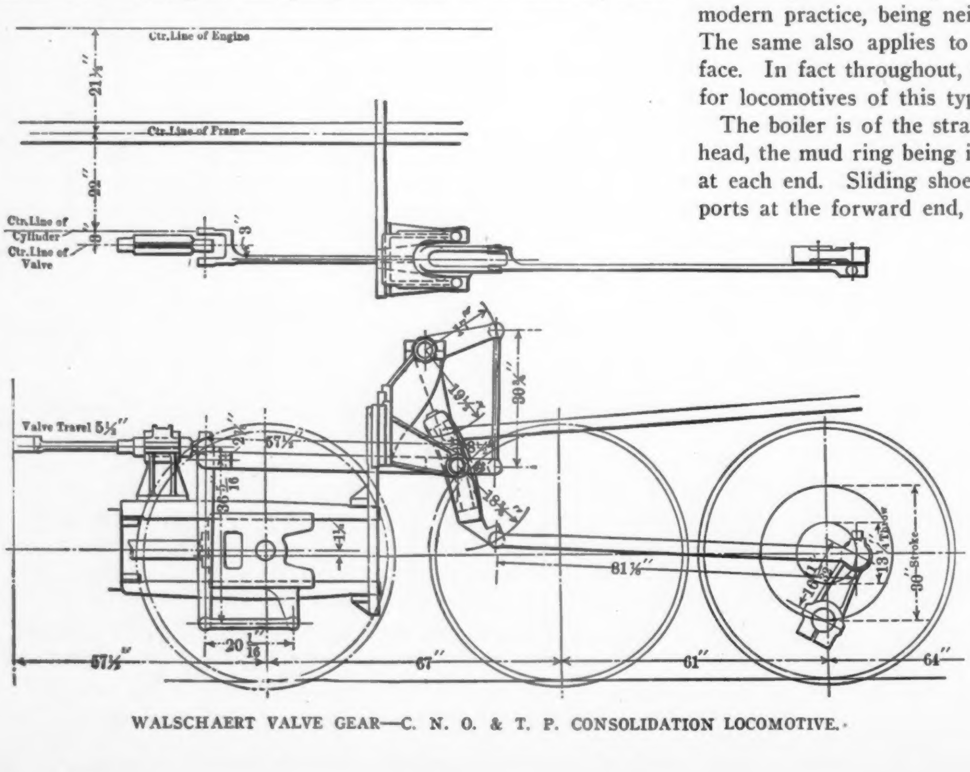
MECHANICAL DRAWING EXAMINATION. FIFTH YEAR APPRENTICES.

SIMPLE CONSOLIDATION LOCOMOTIVE.

CINCINNATI, NEW ORLEANS & TEXAS PACIFIC RAILWAY.

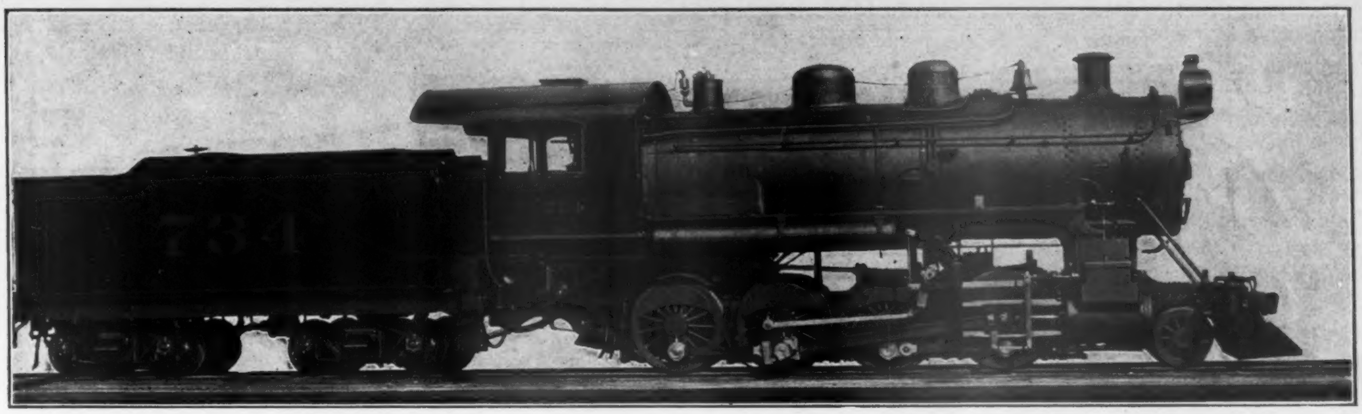
The Baldwin Locomotive Works have recently delivered 25 heavy consolidation locomotives to the Cincinnati, New Orleans & Texas Pacific Railway, which were built from prints furnished by the Railway Company and are known as class D9.

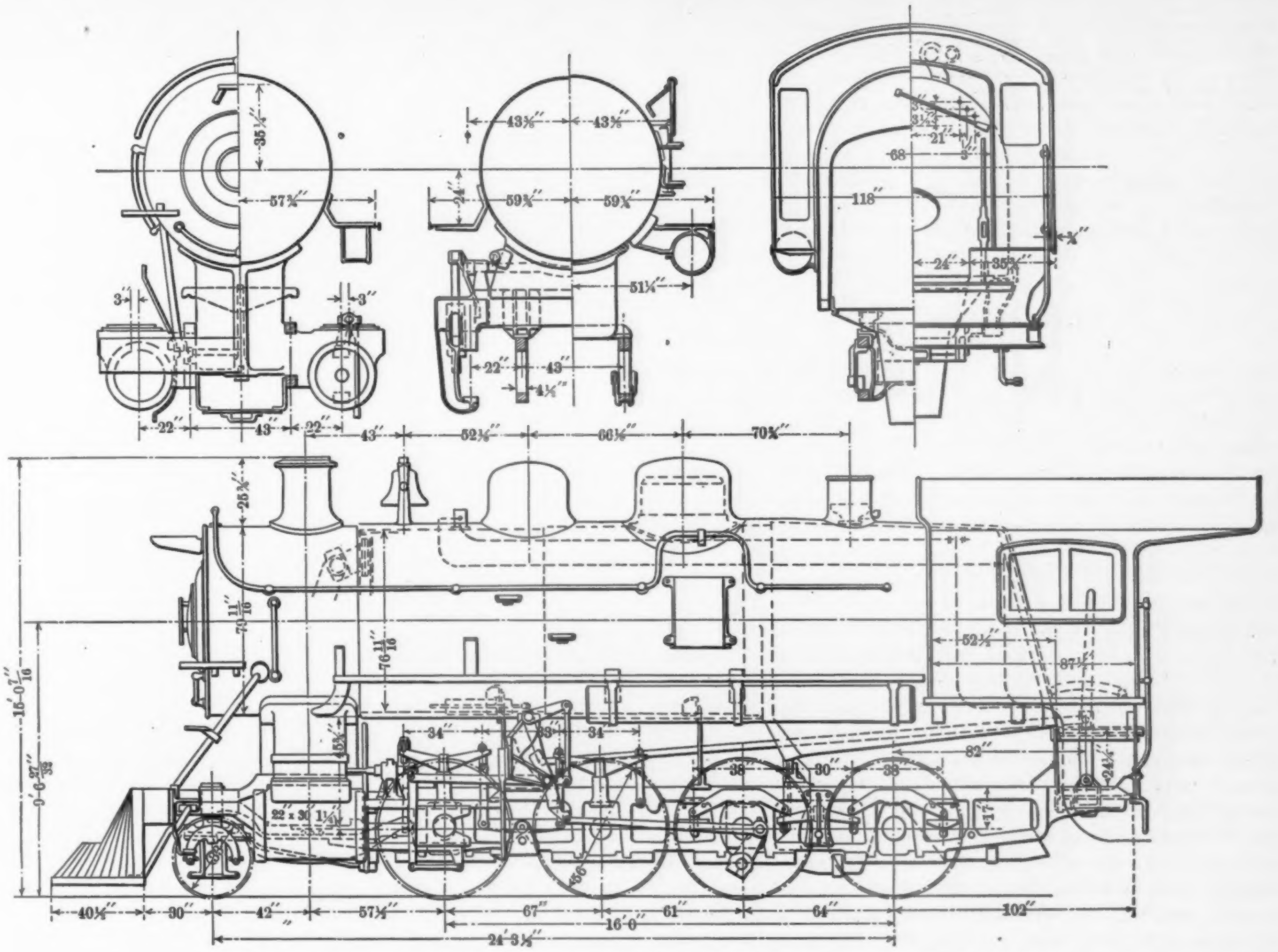
These locomotives have a tractive effort of 44,100 lbs., 56-in. drivers and are an excellent example of straightforward design for a very powerful freight locomotive. They are intended for service over the Cumberland Mountains, where the maximum grade is 60 ft. to the mile and will be rated at 1,000 tons over that division. A study of the ratios given in the following table will show the conservatism of the design throughout. The use of 56-in. drivers with 30-in. stroke is quite common for locomotives intended for slow speed heavy work and permits a speed of 15 miles per hour with a piston speed of approximately 450 ft. per minute. While with a slide valve there will probably be some wire drawing at this speed, there will be no difficulty from this cause at speeds of from 8 to 10 miles per hour. The ratios of heating surface to cylinder volume are a fair average of good modern practice, being neither unusually high or unusually low. The same also applies to ratios of grate area to heating surface. In fact throughout, the ratios fall upon the average curve for locomotives of this type.



WALSCHAERT VALVE GEAR—C. N. O. & T. P. CONSOLIDATION LOCOMOTIVE.

The boiler is of the straight type with sloping throat and back head, the mud ring being inclined and supported on buckle plates at each end. Sliding shoes are also provided as additional supports at the forward end, these being carried on a steel casting, which serves as a frame brace. The boiler barrel is built up of two rings and measures 76 11/16 in. outside diameter at the front end. The longitudinal joints are butt jointed and sextuple riveted. The fire-box is radially stayed with two T-irons supporting the forward end of the crown sheet. The depth of the throat is about 20 in. and the mud ring is 4 in. wide at this point. The mud ring on the sides and back is but 3½ in. wide, which space, however, is increased to 6 in. at the crown sheet. Three hundred and thirty flexible staybolts have been used in the breakage zone of the fire-box. The boiler contains 403 2-in. tubes, so dis-





SIMPLE CONSOLIDATION LOCOMOTIVE—CHICAGO, NEW ORLEANS AND TEXAS PACIFIC RAILWAY.

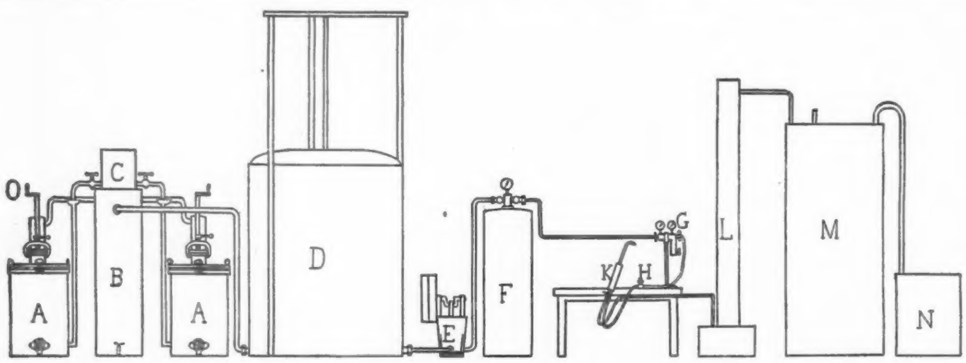
posed as to give approximately ¾-in. bridges on the back flue sheet. Two tubes, one on either side at about the center of the flue sheet, are replaced by stay tubes which consist of a wrought iron bar welded into the back end of the tube and tapered down to 1 in. in diameter, threaded and screwed into the back flue sheet, being riveted over in the same manner as a staybolt. In the front tube sheet these tubes are expanded and beaded. The total heating surface of the boiler is 3,226 sq. ft., of which 175 sq. ft., or 5.42 per cent., is in the fire-box.

It will be noted in the illustration that both of the feed pipes are connected to a boiler check valve on top of the shell. This valve is known as the Phillips patent double boiler check and is manufactured by the Nathan Mfg. Co. It is fitted with a double series of check valves, one valve being inside the boiler shell for emergency purposes and two valves at the top of the casting, one serving each feed pipe. In addition to these there are two shut-off valves behind the check valve so that the latter can be removed and ground in while steam pressure is on the boiler. The feed water enters the boiler directly from the bottom of this attachment and thus is considerably heated by passing through the steam at the top of the boiler. There are no inside feed pipes.

The cylinders are equipped with balance slide valves, having 5½ in. travel, an outside lap of 1 in. and 3/16 in. constant lead. They are operated by the Walschaert type of valve gear, the construction and arrangement of which is shown in one of the illustrations. The link and reverse shaft bearings are bolted to the guide yoke and the radius bar is operated by a hanger connected to it back of the link. The valve stem is supported on a bracket bolted to the top guide, and is rectangular at its bearing point. The eccentric cranks are of cast steel, being split at the large end and clamped and bolted to the main pins. The reach rod connects directly to the downwardly extending arm on the reverse shaft.

The frames are of cast steel with double front rails of wrought iron. Each rail is double keyed to the main frame. A large cast steel foot plate forms a stubstantial frame bracing at the rear end and is assisted by two pieces of channel iron, which constitute the back bumping plate. The general features of construction are clearly shown in the illustrations and the general dimensions, weights and ratios are shown in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	44,100 lbs.
Weight in working order	203,600 lbs.
Weight on drivers	182,000 lbs.
Weight on leading truck	21,600 lbs.
Weight of engine and tender in working order	350,000 lbs.
Wheel base, driving	16 ft.
Wheel base, total	24 ft. 3½ in.
Wheel base, engine and tender	56 ft. 7¼ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.13
Total weight ÷ tractive effort	4.61
Tractive effort x diam. drivers ÷ heating surface	768.00
Total heating surface ÷ grate area	59.80
Firebox heating surface ÷ total heating surface, per cent	5.42
Weight on drivers ÷ total heating surface	56.40
Total weight ÷ total heating surface	63.00
Volume both cylinders, cu. ft	13.20
Total heating surface ÷ vol. cylinders	244.00
Grate area ÷ vol. cylinders	4.10
CYLINDERS.	
Kind	Simple
Diameter and stroke	22 x 30 in.
VALVES.	
Kind	Bal. Slide
Greatest travel	5½ in.
Outside lap	1 in.
Lead, constant	3/16 in.
WHEELS.	
Driving, diameter over tires	56 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	10 x 12 in.
Driving journals, others, diameter and length	9 x 12 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	5½ x 10 in.
BOILER.	
Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	76 11/16 in.
Firebox, length and width	108 x 71¾ in.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	F.-4⅛, S. & B.-3½ in.
Tubes, number and outside diameter	403—2 in.
Tubes, length	14 ft. 6½ in.
Heating surface, tubes	3,051 sq. ft.
Heating surface, firebox	175 sq. ft.
Heating surface, total	3,226 sq. ft.
Grate area	54 sq. ft.
Smokestack, height above rail	180 7/16 in.
Centre of boiler above rail	114⅞ in.
TENDER.	
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	7,500 gals.
Coal capacity	12½ tons.



ARRANGEMENT OF OXYGEN-ACETYLENE PLANT.

(A to H, oxygen apparatus; L to N, acetylene apparatus; A and A¹, oxygen generators; B, cleaning tower; C, catalyser vessel; O. agitator; D, gasometer; E, compressor; F, pressure-reservoir; G, pressure-regulator; H, cock; K, blowpipe; L, safety valve; M, gasometer for constant pressure; N, acetylene generator.)

OXY-ACETYLENE METHODS OF WELDING AND CUTTING METALS.

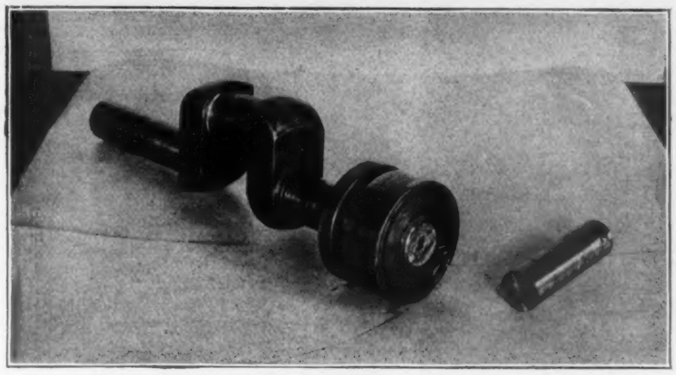
It has been customary for a number of years to weld the butt joints of locomotive boiler shells at the ends and other points where they can be reinforced to withstand the pressure, but the idea of welding the joint for its full length, and of obtaining a strength at this point nearly equivalent to the remainder of the sheet and greater than the usual riveted joint, is altogether a new idea on American railways. Such construction, however, has recently been made possible by the perfection of a comparatively simple apparatus for generating pure acetylene gas and pure oxygen and bringing them together in a blow pipe flame, which has a temperature capable of fusing practically any metal. The same flame can also be used for cutting sheets of steel or other material, performing a perfect job with no more waste of metal than would occur with a saw and with the great advantage that sections of irregular shape can be cut as easily as straight.

Acetylene, the properties and generation of which are generally understood, is a gas very rich in carbon, containing as it does about 92.3 per cent., and it is possible to obtain a temperature higher than that of the oxy-hydrogen blow pipe flame (3,600 degs. F.) by its combustion with air in a Bunson burner. When, however, acetylene gas is burned with oxygen instead of air there is produced the hottest flame known, as a product of combustion, which has a temperature of 6,300 degs. F. or very nearly that of an electric arc. By the proper proportions of the two gases this flame can be made absolutely neutral in its action and have neither an oxidizing or carburetting tendency. These facts have been known for a long time, but the inconvenience and cost of obtaining pure oxygen in a commercial manner has prevented the practical use of the knowledge on any large scale.

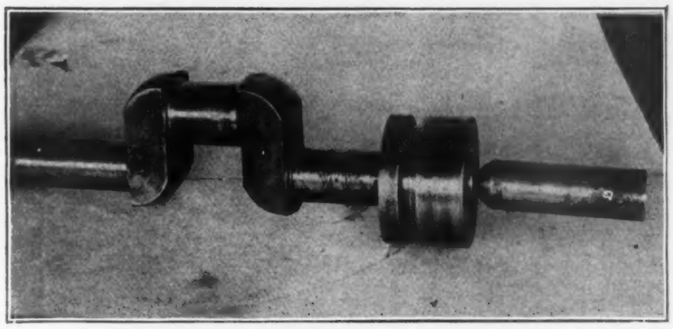
The comparative recent discovery of a powder, or chemical, called "Euprite," which acts in much the same way as does calcium carbide in the production of acetylene gas and permits the generation of chemically pure oxygen in apparatus similar to the acetylene gas generator, has made it possible to commercially utilize this very high temperature at a comparatively low cost.

One of the illustrations shows a diagrammatical view of the apparatus required for this purpose. The section at the left of the blow pipe (K) is for the generation of the oxygen, and the section to the right is for acetylene gas. Both gases are brought to the blow pipe under pressure, there being automatic pressure regulators and stop valves provided so that the amount and pressure of either gas can be varied at will. The blow pipe is of a size corresponding to the work on which it is to be employed, and the gases should arrive at the nozzle at slightly over 2 lbs. pleasure, which will give an exit speed and flow of the gas through the pipes sufficient to counteract any back burning of the mixture before reaching the end of the blow pipe. Metallic gauzes are also provided to prevent the flame throwing back, and it is said that the danger of accident or explosion with the apparatus is practically eliminated, and that an inexperienced operator is able to control it without danger.

In welding two pieces of any considerable thickness the edges are beveled so that it is possible to heat to the bottom of the weld. The blow pipe flame is directed into the opening until the two edges are fused, and at the same time a rod of the same metal, which is held in the flames, is fused and fills the space between the sheets in much the same manner as in soldering. This work being carefully done, results in a joint which is practically a part of the sheet, and outside of the fact that it has not been possible to work the metal in a joint and thus increase its strength, gives a connection which is equal in strength to any part

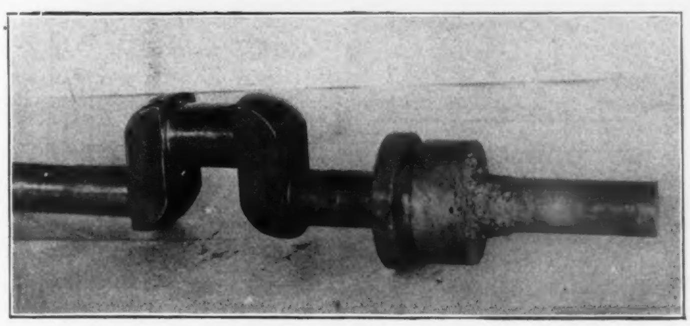


THE BROKEN CRANK SHAFT.



READY FOR WELDING.

BEING WELDED.



READY FOR THE MACHINE.

of the sheet. In practice, by building up the metal on top of the joint, and thus giving a greater sectional area, the joint is made nearly equal in strength to the remainder of the sheet.

The same method can be used in repairing boiler or firebox sheets which have cracked along the edges or at staybolts, or been corroded away at certain points, and the sheets restored to their full strength by the building up with new material to any extent desired. Repairs of this nature can be safely considered as an integral part of the sheet rather than as a patch.

The illustrations show a broken crank shaft and the different processes followed in welding the two sections together, making it practically as good as new and at a very slight expense compared to the cost of constructing a new shaft. The work shown in the illustration was performed by the Worcester Pressed Steel Company, which has a plant of this kind in operation.

For cutting sheets the flame, by change in pressure, is somewhat elongated and given somewhat of an oxidizing effect and simply burns a narrow cut through the plate following any desired contour. The edges of the sheet are smooth and even, and plates up to 5 in. in thickness have been cut in this manner.

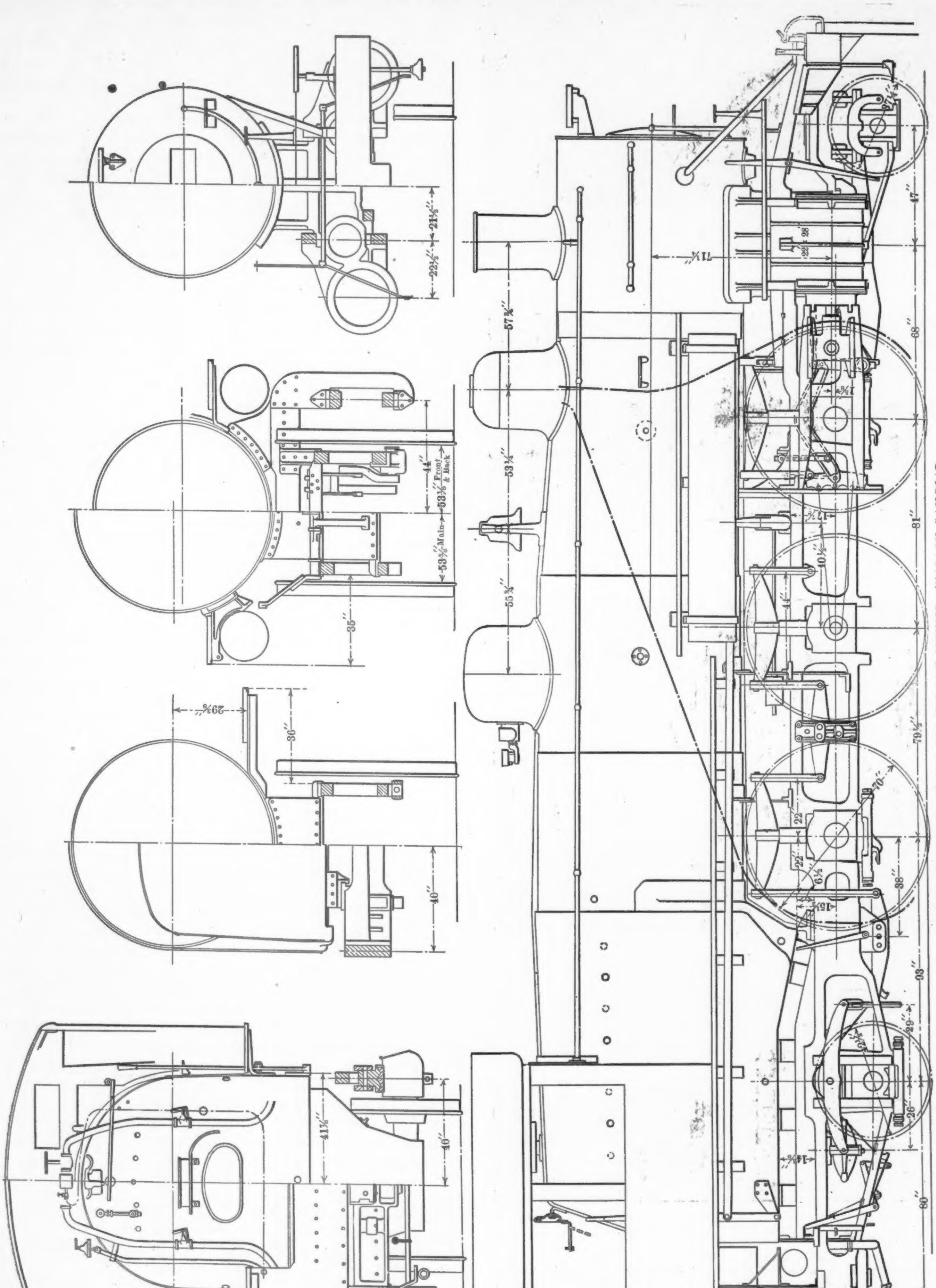
This process is not only adapted for making tanks, boilers, tubing and pipe joints and angles, and for replacing brazing and riveting in many instances, but it also can be used effectively to weld steel castings. Many defective castings have been saved in the foundry by the filling in of the blow holes with new metal or welding together smaller sections of the castings which have been broken apart. It will also, no doubt, prove to be a great time-saver by permitting small leaks or breaks to be repaired without removing the parts from the locomotive.

This system of welding is known as the auto-genous welding and the process and apparatus is controlled by the Industrial Oxygen Company, Hanover Bank Building, 11 Pine Street, New York City.

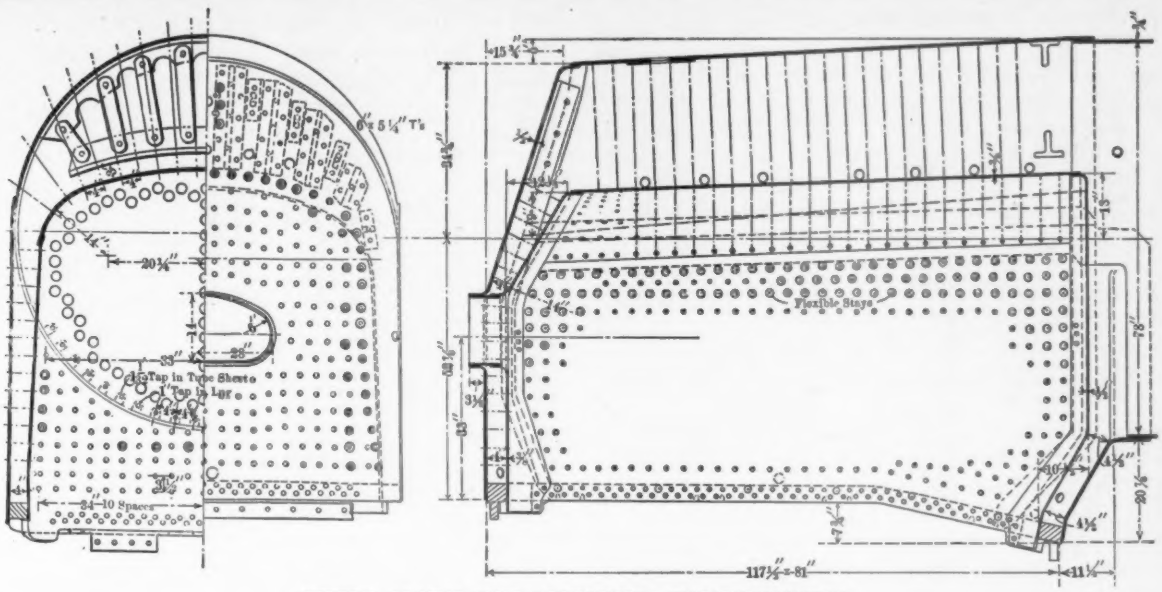
SHOP LIGHTING.

To furnish the most up-to-date machinery and tools, and pay the present high prices for labor, and then to handicap the workmen by insufficient, or improperly placed lights, is a fallacy too patent to require argument; and still such cases are by no means uncommon. It will perhaps add to the impressiveness of this statement to make use of a few computations. Let us take as a basis the electric light, which is admittedly the most expensive form of artificial illumination, and let us say that the current is purchased at the retail price of 10 cents per unit (kilowatt hour). A 16-candle-power lamp can be burned 18 hours by the use of one unit, that is, at a cost of 10 cents, or 55 mills per hour. The ordinary workman, receiving, say, 20 cents per hour, would only have to lose a trifle over a minute and a half out of an hour to represent a loss equal to the cost of the light; while a skilled workman, receiving, say, 50 cents per hour, would have to lose only a little over half a minute ever hour to represent a similar loss. In other words, the ordinary workman losing 13 minutes in a day of 8 hours, or the skilled workman 5 minutes in the same time, would equal the cost of running the lamp for the entire working day. But instead of electricity costing 10 cents per unit, it may be generated in large works, where power is already at hand, as well as the fixed charges of superintendence, etc., as low as 2 cents per unit, which would reduce the above figures to one-fifth; that is, the average workman would have to lose only about 2½ minutes in an entire working day of 8 hours, and the skilled workman but a little over a minute, to represent the cost of the lamp for a day. But the loss in wages is not all; loss in time of the operative represents a loss from the non-use of the machine. And again, besides there being a reduction in the amount of product, there is often a reduction in quality also, which is far more serious than the reduction in quantity.—*The Illuminating Engineer.*

PRODUCER GAS ENGINE PLANT MOST ECONOMICAL.—Personally, I believe that a gas-engine plant, making its own producer gas, will operate at least as reliably as a steam plant and will use from 30 to 60 per cent. less fuel, depending principally on the size of the steam plant. The drawbacks to the gas plant are, in my mind, the first cost, approximating $200 per kilowatt when rated so as to have a 33⅓ per cent. overload capacity, and the small size of units—the largest gas engine now built being only of about 3,000 kilowatt capacity.—*Paul Winsor before the Amer. Street and Interurban Ry. Eng. Assoc.*



PRAIRIE TYPE LOCOMOTIVES FOR FREIGHT SERVICE—WABASH RAILROAD.



FIREBOX, PRAIRIE TYPE LOCOMOTIVE—WABASH RAILROAD.

SIMPLE PRAIRIE TYPE LOCOMOTIVES.

WABASH RAILROAD.

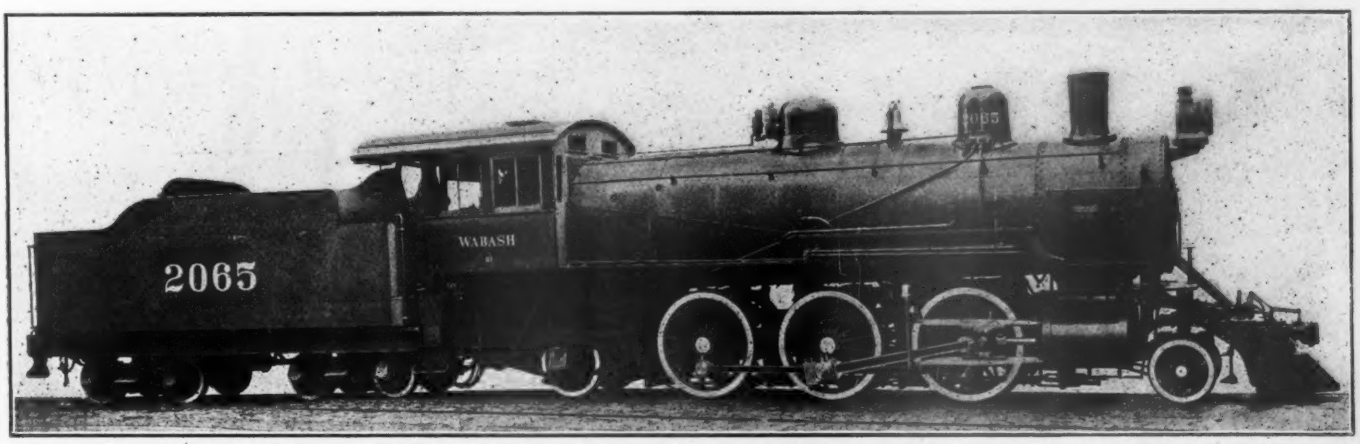
The American Locomotive Company is delivering an order of 60 Prairie type locomotives to the Wabash Railroad, of which 30 are fitted with 70-in. drivers, and intended for high-speed freight service, and 30 with 64-in. drivers for low speed freight service. In all other respects, except the diameter of the front truck wheels, the two classes are alike. The high speed engines have a tractive effort of 32,900 lbs., and the low speed, 36,000 lbs.

This design is very similar to, and in many respects identical with locomotives of the same type in service on the Chicago, Burlington & Quincy Railway, which were illustrated in this journal in August, 1906, page 300. The Burlington engines, however, by virtue of higher steam pressure and 1-in. smaller drivers give a higher tractive effort and are also somewhat heavier both in total weight and weight on drivers.

The boiler is of the extended wagon top type, 70 in. outside diameter, at the front flue sheet and 79½ in. at the connection to the fire-box. The front flue sheet is secured in a ring of 1-in. plate to the interior of which is also fastened the front barrel sheet. The ⅝-in. smoke box sheet is riveted to the outside of this ring. The flue sheet is set 31 in. from the center line of the stack and 71½ in. from the forward end of the smoke-box. The flues, of which there are 301 2¼-in., are 19 ft. long and give a heating surface of 3,368.5 sq. ft. The fire-box, as will be seen in the illustration, is of the radial stay type with one T-iron sling stay support at the front end. Flexible staybolts are used in the breakage zones along the top and corners of the side sheets and in the throat sheet. The back head is vertical to the top of the fire door, from which point it slopes inward quite sharply. The water leg is of the same width, 4 in., from the mud ring up to the bend in the head, from which point it spreads to 9 in. at the connection to the crown sheet. The water space in the throat is 4½ in. in width at all points. The single fire door measures 14 x 28 in. Two non-lifting injectors, feeding to check valves in the usual location, are used.

The boiler ratios are liberal, there being 65½ sq. ft. of heating surface to one square foot of grate area and 288 square feet to one cubic foot of cylinder volume. There is one square foot of heating surface to 42½ lbs. weight on drivers.

The 22 x 28-in. cylinders are served by 12-in. piston valves placed inside of the cylinders on a line with the frames. The Stephenson type of valve gear is employed, the eccentrics being on the second or main axle and the motion is transferred from the link through a transmission bar over the front axle. This bar is supported by a double hanger at its rear end and connects at the forward end to a rocker arm supported from a bearing secured below the bottom frame rail. The valve stem connection is made through a link pivoted to the rocker arm above the transmission bar connection.

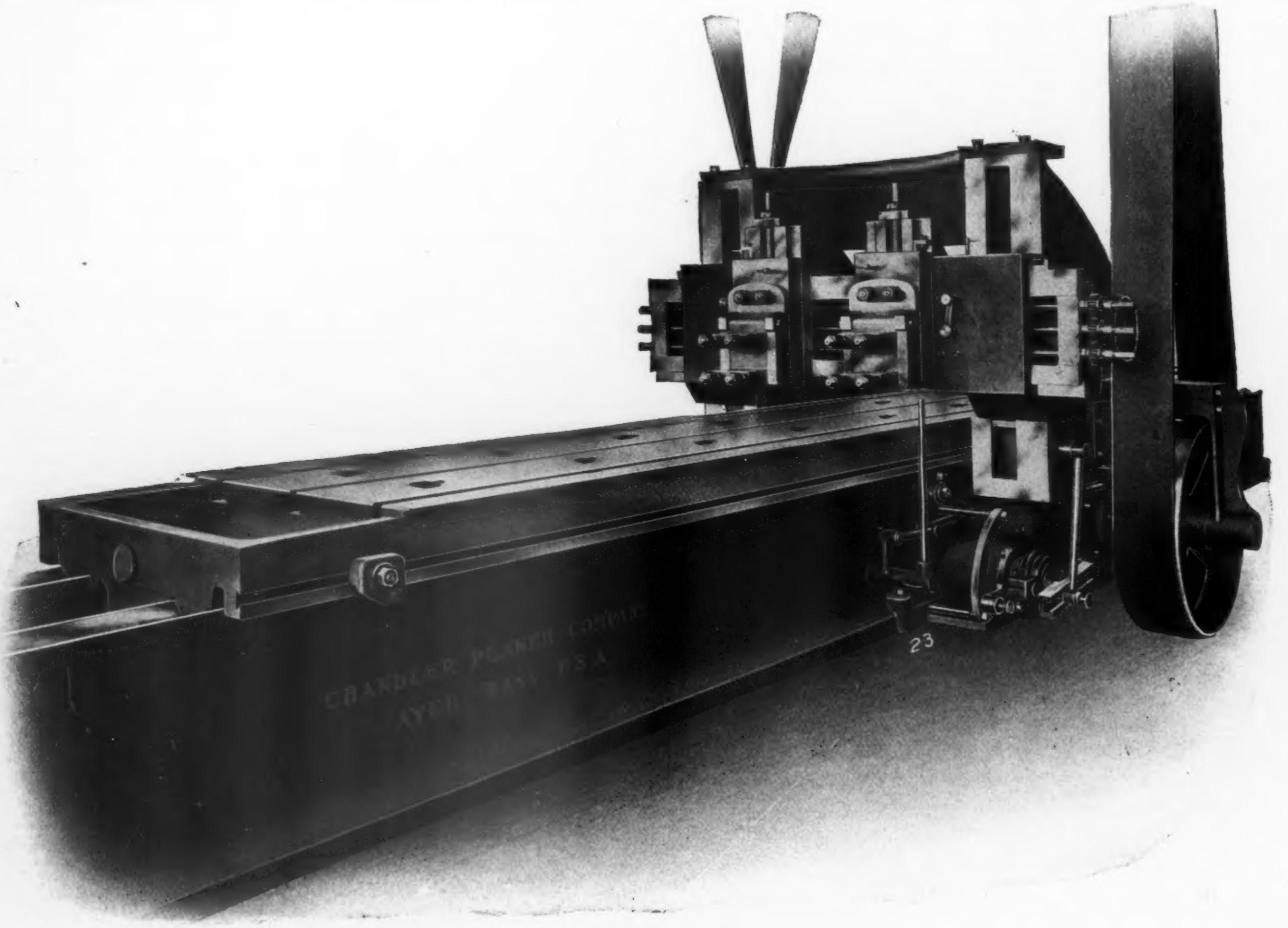


PRAIRIE TYPE FREIGHT LOCOMOTIVE—WABASH RAILROAD.

The same design of trailer truck frame that has been used on the Burlington for many years is found on these engines. This consists of a heavy cast steel cross bar forming a connection between the main frames, set at 43-in. centers, and the trailer truck frames set at 80-in. centers. The trailing wheels have outside journals, the equalizer resting on top of the journal box, as shown in the illustration.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	32,900 lbs.
Weight in working order	203,100 lbs.
Weight on drivers	143,100 lbs.
Weight on leading truck	26,000 lbs.
Weight on trailing truck	34,000 lbs.
Weight of engine and tender in working order	358,417 lbs.
Wheel base, driving	13 ft. 4½ in.
Wheel base, total	30 ft. 8½ in.
Wheel base, engine and tender	63 ft. 4¼ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.35
Total weight ÷ tractive effort	6.18
Tractive effort x diam. drivers ÷ heating surface	647.00
Total heating surface ÷ grate area	65.50
Firebox heating surface ÷ total heating surface, per cent	5.38
Weight on drivers ÷ total heating surface	42.50
Total weight ÷ total heating surface	57.00
Volume both cylinders, cu. ft	12.30
Total heating surface ÷ vol. cylinders	288.00
Grate area ÷ vol. cylinders	4.42
CYLINDERS.	
Kind	Simple
Diameter and stroke	22 x 28 in.
VALVES.	
Kind	Piston
Greatest travel	6⅛ in
Outside lap	1⅛ in.
Inside lap	⅛ in.
Lead in full gear	1/32 in
WHEELS.	
Driving, diameter over tires	70 in.
Driving, thickness of tires	4 in.
Driving journals, diameter and length	9½ x 12 in.
Engine truck wheels, diameter	37¼ in.
Engine truck, journals	6 x 10 in.
Trailing truck wheels, diameter	42½ in.
Trailing truck, journals	8 x 12 in.
BOILER.	
Style	Ext. Wagon Top
Working pressure	200 lbs.
Outside diameter of first ring	70 in.
Firebox, length and width	108⅛ x 72¼ in.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	F-4½, S. & B. 4 in.
Tubes, number and outside diameter	301—2¼ in.
Tubes, length	19 ft.
Heating surface, tubes	3368.5 sq. ft.
Heating surface, firebox	190.5 sq. ft.
Heating surface, total	3559 sq. ft.
Grate area	54.24 sq. ft.
Smokestack, diameter	19½ in.
Smokestack, height above rail	15 ft. ½ in.
TENDER.	
Tank	Water Bottom
Frame	Steel
Weight, empty	61,150 lbs.
Wheels, diameter	33½ in.
Journals, diameter and length	5½ x 10 in.
Water capacity	7,700 gals.
Coal capacity	15 tons



CHANDLER CLUTCH PLANER.

CHANDLER CLUTCH PLANER.

With the introduction of high-speed steels, the individual motor drive and the resulting improvements in shop practice, the limitations of the ordinary type of planer, and especially of the larger sizes, have become very evident. Not only were the machines in use four or five years ago not of sufficiently strong and rigid construction, but it seemed to be impossible to speed them up to take full advantage of the new conditions. The various builders approached the problem from different view-points, and each in his own way has tried to solve it. The result has been a marked improvement in planer design and a number of beliefs which were current a few years ago, as to its operation and construction, have proved erroneous.

The two most obvious limitations of the belt-shifting planer are the widths of belts that can be economically shifted and the speed at which pulleys and journals can be safely run. In 1904 the Chandler Planer Co., of Ayer, Mass., built a planer which attracted widespread attention because of the remarkable work which it did. It included several radical improvements in design and was described on page 397 of our October, 1904, issue. The most important features were the use of case-hardened shafts and a second or accelerating return belt. The cutting speed was arranged to suit the material which was to be machined and at the end of the cutting stroke the platen was reversed by a belt running at a speed to secure the best reversal. As soon as the platen had been reversed and started on its return stroke, the reversing belt was thrown off and succeeded by another belt of much higher speed. At the end of the return stroke the action of the belts was reversed, the fast belt going off first and being followed by the slower or reversing belt, which retarded the mechanism just preceding the reversal to the cutting stroke.

With the higher cutting speeds and the increased weight of

parts and of the platen load on the larger size planers, and with several tools cutting at the same time, there was a call for an increased belt ratio and the belt problem again became serious.

To relieve this difficulty it soon became evident that the shifting belts must be replaced by clutches or some similar device. The requirements of the clutch in planer operation are very different and much more severe than that for clutches in other kinds of service, and it was found necessary to design a clutch along new lines. The Chandler Planer Company has designed such a clutch and adapted it to their planer and for a considerable period have been submitting it to severe and protracted tests.

The planer is 42 in. x 20 in. x 20 ft. and weighs about 30 tons. In order to test the clutches on the severest class of work, the planer is of the frog and switch type. Its cutting speed is 20 ft., with a return of 4 to 1. The cutting belt is 10 in. double and runs at a speed of 1,860 ft. per minute, with ratio of 93 ft. of belt to 1 ft. of platen. The reversing belt is 5 in. wide and runs at a speed of 3,900 ft. per minute. The dimensions of most of the tools used in the tests were 2½ in. x 3 in., and were of various makes of high-speed steels.

The planer removes the side of the head, up to the web, on a pair of extra hard 70 lb. relay switch points, cutting back 9 ft. in less than 6 minutes. It is expected that this time can be reduced at least 30 per cent. At a cutting speed of 20 ft. it removed from a 40-point carbon steel forging, a chip ¾ in. deep, with ¾ in. feed. It runs for hours on a 14 in. stroke, without giving the slightest indication of injurious heating or wearing. It is said to reverse as smoothly as the best belt-shifting planer.

The clutches, which are two in number, of the multiple disc type, are located inside the bed of the planer on the second shaft, and are set by mechanism operated by the planer. All the dog or the operator can do is to trip the mechanism. The advantages claimed for the clutches are that they provide a maximum bearing surface with a fixed minimum slip, avoidance of metal contact, a positive rather than a friction locking, elimination of shock, reduction of momentum, locking proportionate to the load, and impossibility of slipping when once set.

These results are secured in the following manner:

The heating problem, which, perhaps, of all others, is the most to be feared, is overcome by sufficiently large bearing surfaces made up of multiple discs, alternate discs being keyed to the shaft and shell of the clutch, and all moving laterally. When the clutch is closed the discs are pressed together.

The amount of slip before locking, is accurately determined by a timing mechanism between a primary clutch and the main clutch.

The two clutches operate on the principle of differentials. The amount of locking of the main clutch is, therefore, determined by the difference in movement of the two clutches. It is obvious that any slip of either clutch increases the grip of the main clutch, and insures a locking in proportion to the load. In a sense, the main clutches are positive rather than friction.

The shell of the main clutch is a case within which the discs run in a bath of oil. The oil not only lubricates and reduces the chance of heating, but serves as a cushion which gives the clutches a soft, smooth engagement. Examination of the discs, after severe and protracted tests, indicate that a film of oil is always interposed between their faces. It is obvious that so long as the discs do not come into metal contact there can be no wearing and no heating.

The clutches are two in number, one engages with the cutting belt shaft and one with the reversing belt shaft. Consequently, one clutch is idle while the other is in operation. This gives the idle clutch a chance to rest and become thoroughly lubricated before engaging.

The clutches are self-contained. When engaged, both the primary and main clutch revolve as one clutch.

As momentum is the product of weight multiplied by velocity, every material reduction of either greatly reduces the difficulty of reversing. In the Chandler clutch planer the clutches are on the second shaft, and the only parts of the clutch that reverse are the discs that are keyed on the shaft. The clutch case and all the other operating mechanism moves constantly in one direction.

Supplementing the primary and main clutches is a mechanically operated device which insures a proper and positive engagement of the primary clutch and leaves nothing to the mischance of dogging, and provides a proper margin of safety to meet all the conditions of varying platen load.

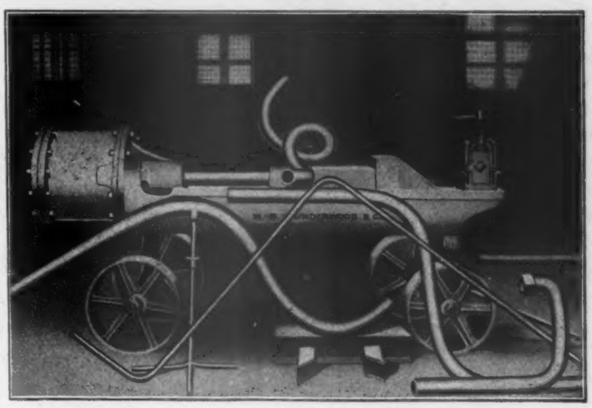
The clutches are located inside the bed of the planer. They, therefore, add nothing to its size, and do not, in any way, change its general appearance.

To run the planer light at a cutting speed of 20 ft. with return speed of 4 to 1, requires 6 to 7 h.p. on either stroke. The reverse requires about 20 h.p. On severe cutting loads the clutches have demonstrated ability to hold without slipping under a load of over 50 h.p.

Some surprising cutting results were obtained with high-speed steels on this planer. Most frog and switch builders claim that they are able to reach the limit of their tool steels, with planers of far less power than is utilized by the Chandler clutch planer. The management of Chandler Planer Company claim that its planer secures a greatly increased cutting efficiency because of its steadiness. They contend that the molecular structure of high-speed steel is upset by shock, especially at a high temperature; that this is demonstrated by the fact that after a tool is forged it has no cutting capacity until the molecules are permitted to readjust by the process of annealing. If the planer vibrates and chatters while the tool is in the chip, there takes place in the tool, especially in its cutting edge, a disturbance practically the same as that which results from forging.

PNEUMATIC PIPE BENDING MACHINE.

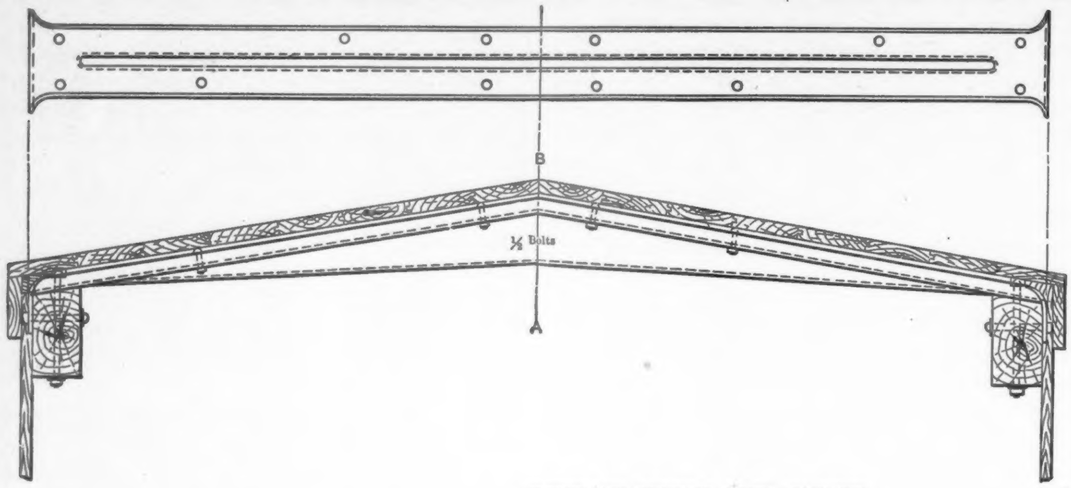
The portable pneumatic pipe bending machine, which is quite clearly shown in the accompanying illustration, is being placed upon the market by H. B. Underwood & Co., Philadelphia, Pa. One of these machines has been in practical use in a large railroad repair shop for several months and has done all the pipe

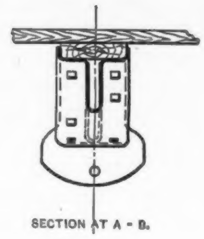


PORTABLE PNEUMATIC PIPE BENDING MACHINE.

bending required in connection with the locomotive equipment, air brakes and regular work. It does not flatten or injure the pipe in any way and will make a right angle bend in a 2-in. pipe in two minutes. Dies are furnished of standard radius, for locomotive work, for from ½ to 2-in. pipe, and special dies of any required radius or shape may be furnished to order.

DEFINITION OF A MECHANICAL ENGINEER.—"The mechanical engineer is one who by science and by art so adapts and applies the physical properties of matter and so controls the forces which act through them as to serve the use and convenience of man and to advance his economic and material welfare. He does this mainly by storing and liberating motor energy through machines and apparatus which he designs and installs and operates for the purpose of fostering and developing tne processes of industrial production which use and require such power upon a large scale."—*Pres. Hutton before the Amer. Soc. Mech. Eng.*





CLEVELAND PRESSED STEEL CARLINE.

PRESSED STEEL CARLINES.

One of the most important developments in box car design and construction has been the introduction of pressed steel carlines. That this type of carline is made in one piece and that it can be used to replace the wooden carline without any change in the construction of either the car body or the roof, are important points in its favor. Compared to the wooden carline a stronger roof support may be gained with a less number of steel carlines, with less weight per car, and in most cases with greater inside clearance.

The Cleveland Car Specialty Company of Cleveland has designed a new pattern of pressed steel carline, specially adapted to the outside metal roof, in which a channel section is reinforced by a U-section pressed into the web of the channel. The channel section, with a 5-in. nailing strip bolted to it, gives a wide support for the longitudinal course of boards and the additional strength due to the U-section makes a stronger carline with less weight than any possible combination of wood and iron, or any commercial shape that may be used.

The importance of adding strength to freight cars without increasing their weight is generally recognized. Tests and experiments show that in practically all cases a pressed steel shape will give better results in this respect than commercial shapes, as additional strength may readily be provided where it is required. This is specially true of compound shapes, which must be built up and bolted or riveted together.

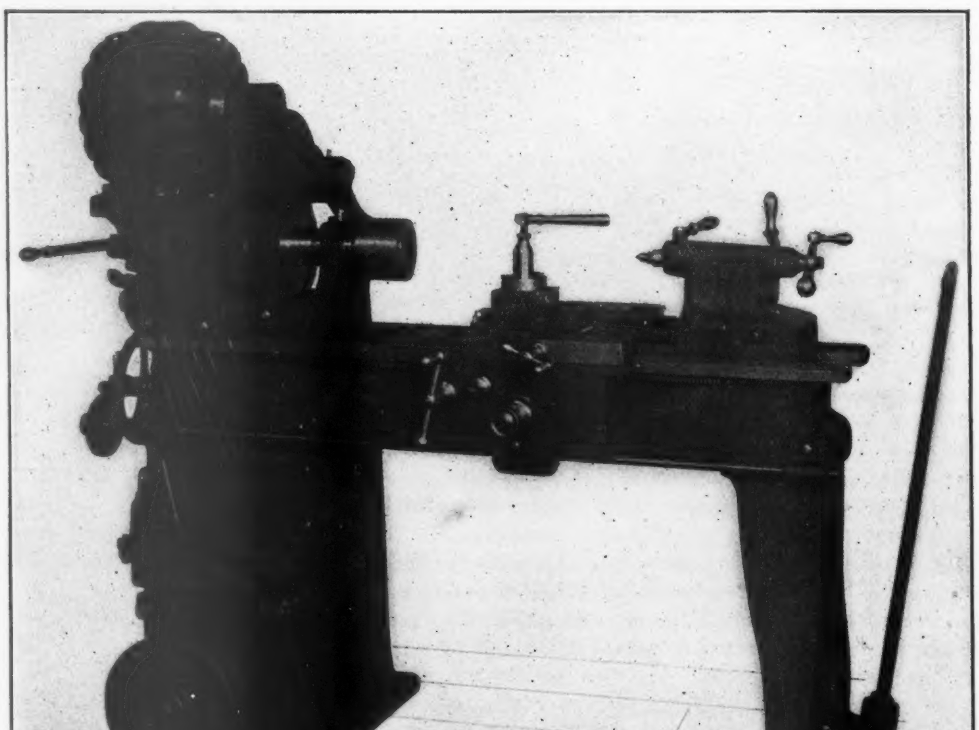
The Cleveland pressed steel carlines are made in a number of different patterns suitable for different types of construction. The new type, which has been described, is said to be an ideal one for the outside metal roof, combining, as it does, the superior design with lightness, and extending over the side plates.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION.—The International Railway and the Master Steam Boiler Makers' Associations consolidated last spring to form this Association. The next convention will be held in Detroit, May 26, 27 and 28. Mr. George Wagstaff, supervisor of boilers of the New York Central Lines, is its president.

PORTABLE LATHE FOR ERECTING SHOPS.

A portable bolt turning machine is being used to considerable advantage in the erecting shop of the Canadian Pacific Railway at Angus, Montreal. The base is provided with three wheels which are fitted with roller bearings. When the handle is in an upright position the two forward legs of the bed rest on the floor and the machine is level. When the handle is pulled forward these legs are raised from the floor, the weight resting on the small front wheel, and the machine may be easily moved from place to place. Three-quarters of the weight rests upon the two large wheels at the rear.

The machine is driven by a 2 h.p. Westinghouse induction motor, 1,700 r. p. m., the starting device for which is shown at the front of the machine. The gearing is arranged for either 200 or 400 revolutions per minute of the lathe spindle; change from one speed to the other is made by moving the lever which controls the friction clutches. The nose of the spindle is fitted with a chuck, suitable to the size of bolt which is being turned and into which the bolt head fits. This merely drives the work,



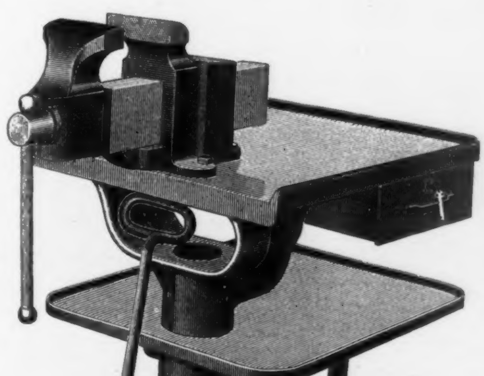
PORTABLE LATHE FOR ERECTING SHOPS.

which otherwise is held between centers in the ordinary manner. Different feeds are provided for by means of change gears. In other respects the machine is a standard engine lathe without a screw feed. It is manufactured by the Williams & Wilson Company of Montreal and has a swing of 16½ in. and a length between centers of 26 in.

PORTABLE WORK-BENCHES FOR ROUND HOUSES AND ERECTING SHOPS.

The portable work benches, shown in the accompanying illustrations, were especially designed for use in roundhouses and erecting shops by the Western Tool & Manufacturing Company

PORTABLE TOOL STAND.



PORTABLE VISE STAND.

of Springfield, O. Shop managers seem to be realizing, more and more, the importance of adding facilities of this kind for the purpose of increasing the output and in the interests of time saving and economy. When the handle is in an upright position, as shown, the brakes on the rear wheels are applied and the front part of the base rests on the floor. Pulling the handle forward releases the brakes and throws the front wheel into operation, allowing the bench to be easily moved. The drawers are fitted with locks.

The vise stand is made in two sizes, as follows:

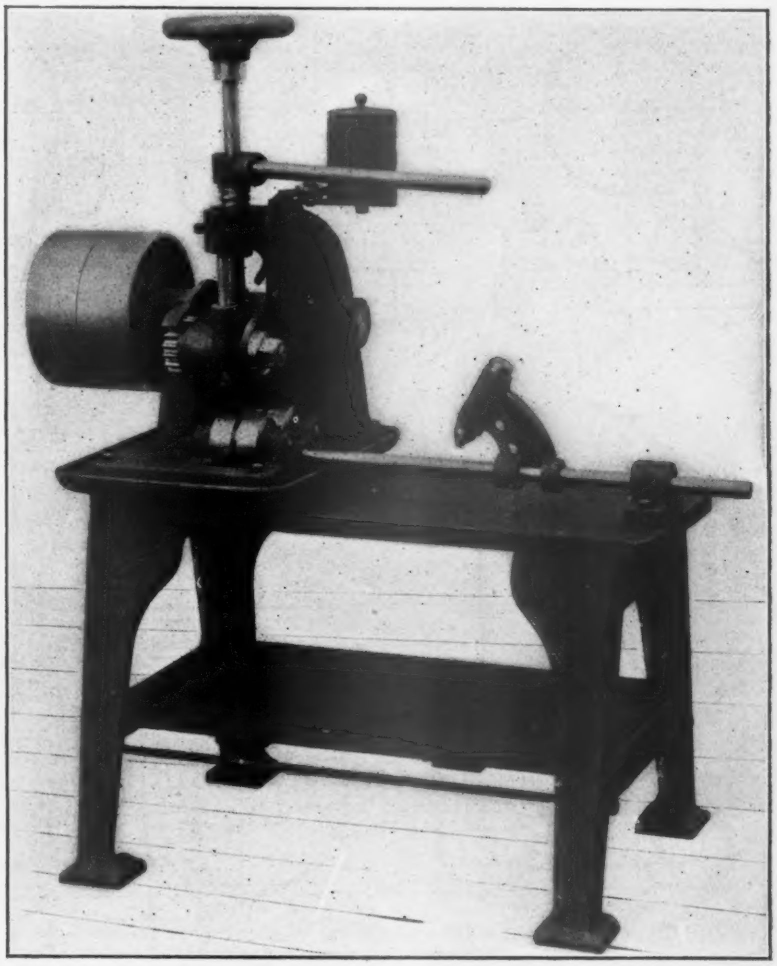
Height	44 in.	44 in.
Base	26 in.	29 in.
Table and shelf	17 x 21 in.	21 x 25 in.
Weight, crated	350 lbs.	575 lbs.

These stands may be furnished with either plain jaw vises or combination pipe jaw vises.

The tool stand is 40 in. high; the top shelf is 22 x 30 in. and the others 22 x 24 in. The distance between the shelves is 7 in. The stand weighs 300 lbs. and may be furnished either with or without the vise.

NEW PIPE AND TUBE CUTTER.

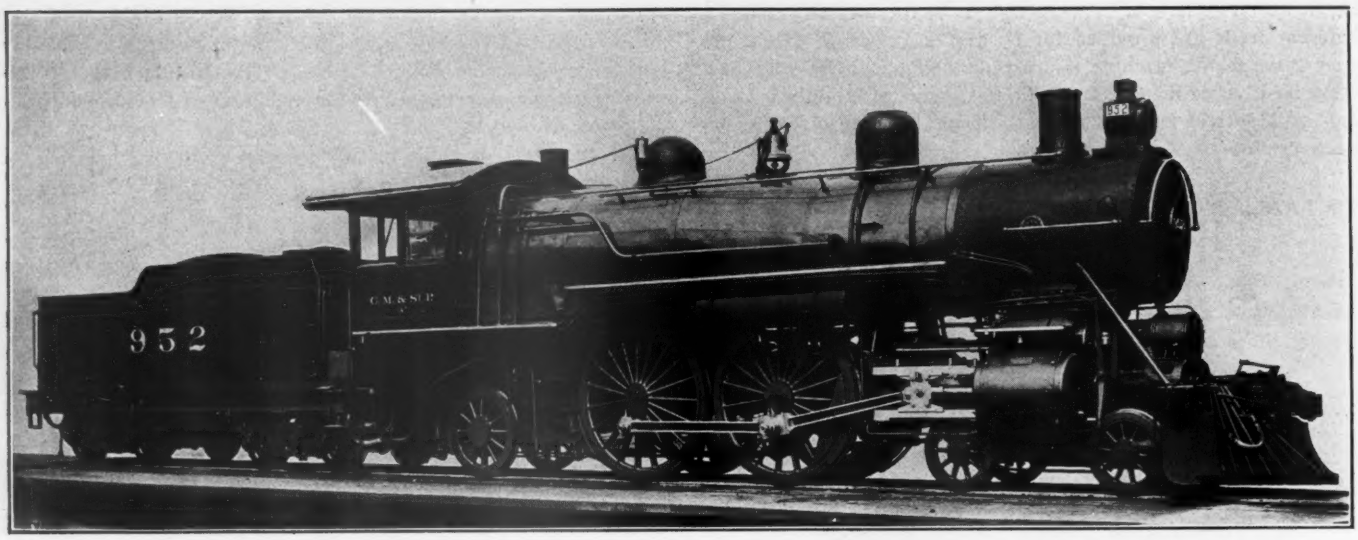
A new rolling pipe and tube cutter, designed for quick and accurate service, with a capacity of from 1 to 4 in., has just

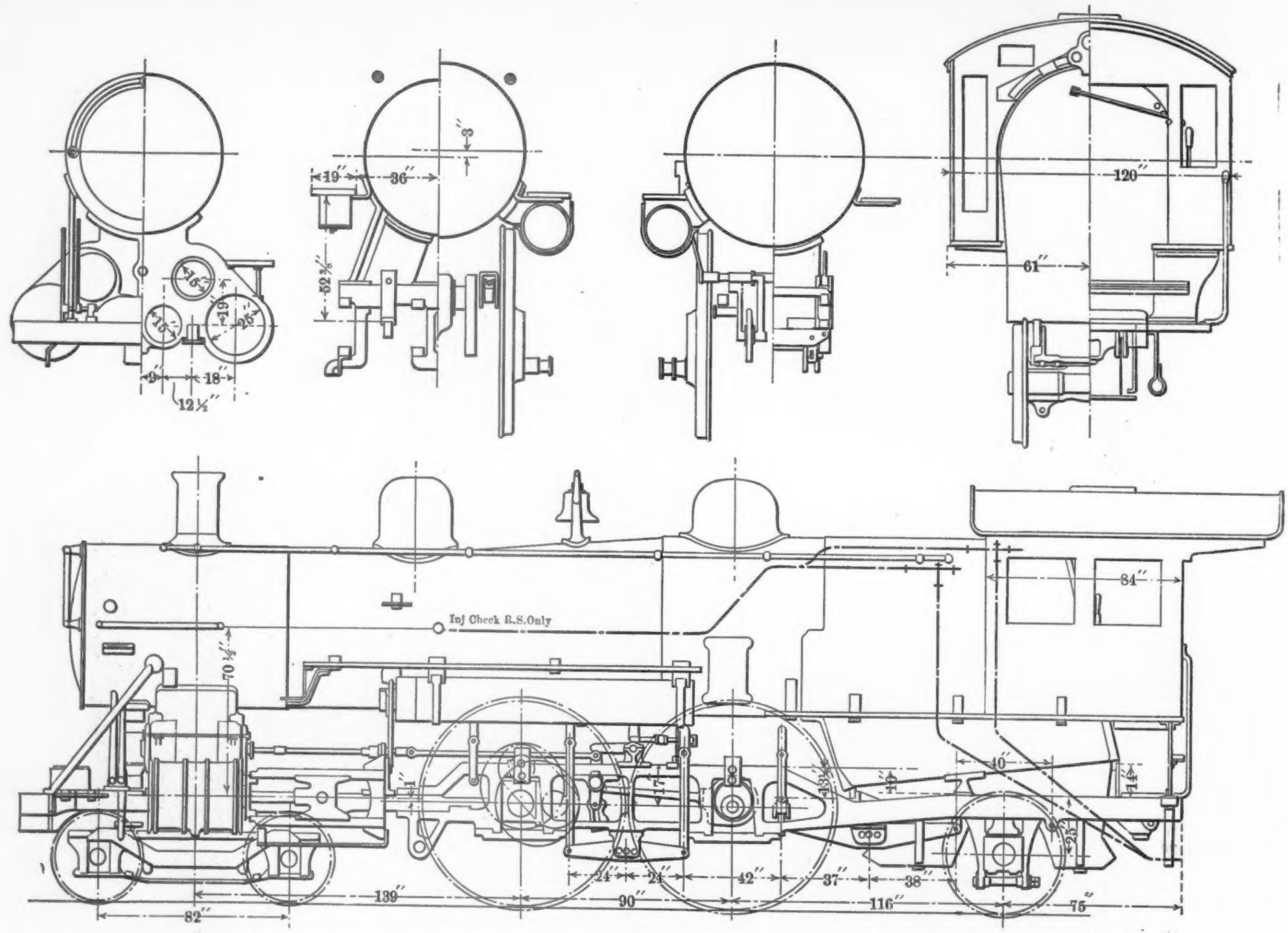


NEW PIPE AND TUBE CUTTER.

been placed on the market by the Bignall & Keeler Mfg. Co. of Edwardsville, Ill. The cutting is accomplished by lowering the cutter and not by raising the pipe, thus allowing the pipe to bear evenly across the entire length of the roll.

The cutter shaft is carried in an arm which is pivoted at one end and is raised and lowered by means of a screw. The cutter is adjusted until it just clears the pipe and then by using the lever, which terminates in a nut having a coarse thread, the cutter can be quickly raised and lowered. The gears are cut from the solid. The machine may be furnished either with or without a table. When a table is furnished a movable stop is provided for cutting duplicate lengths.





BALDWIN BALANCED COMPOUND ATLANTIC TYPE LOCOMOTIVE, CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

BALANCED COMPOUND PASSENGER LOCOMOTIVES.

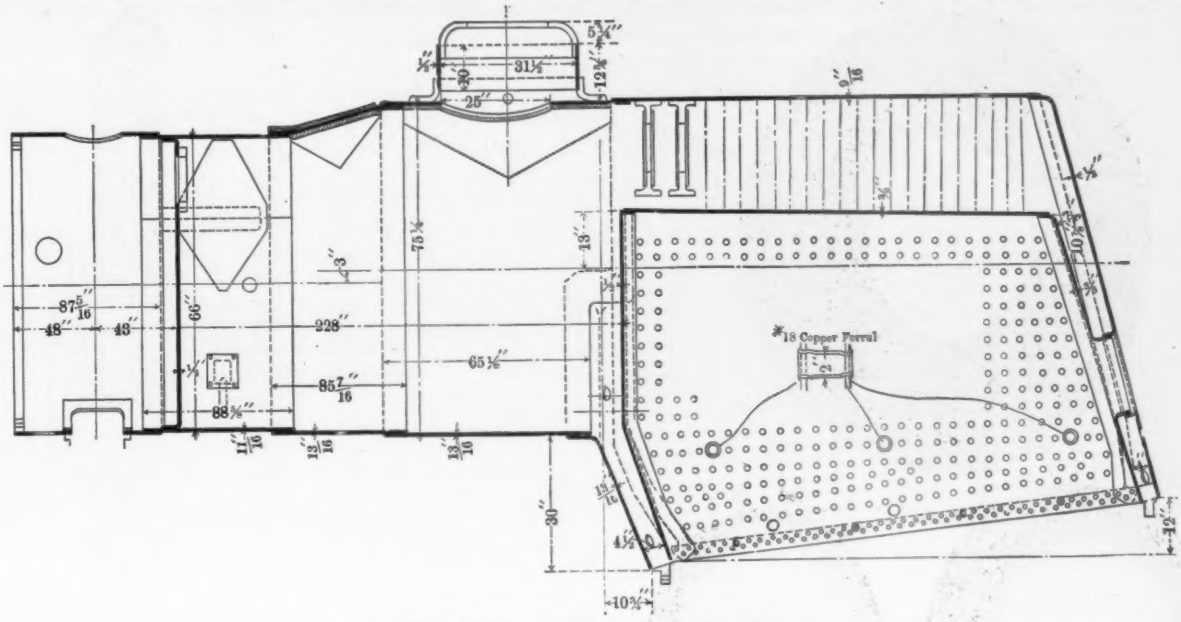
CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

The Baldwin Locomotive Works has recently delivered two balanced compound Atlantic type locomotives to the Chicago, Milwaukee & St. Paul Railway, which are to be used in fast passenger service and have a tractive effort of 22,200 lbs. working compound.

These locomotives, as far as the arrangement of cylinders and running gear is concerned, do not differ in any essential features from most of the Baldwin compound locomotives of this type. The cylinders are set side by side in a horizontal line and all drive on the front pair of wheels; the cranked axle being of the built up type with a cast steel central web. The Stephenson type of valve gear is used, the eccentrics necessarily being on the rear driving axle. The link is located just back of the front axle and the rocker arm is so placed as to connect directly to the link block. The top of the rocker arm extends over the frame so as to connect directly to the valve rod, which passes along the top of the frame from this point to the 15-in. piston valve. This rod has a bearing in the guide yoke and is provided with a knuckle joint just back of this bearing.

The frames are of cast steel 4½ in. wide with single front frames of wrought iron. The DeVoy type of trailer truck* is used, which employs a trailer truck frame of the slab form 2¾ in. wide by 10 in. deep. The trailer truck boxes form part of a steel casting extending across the engine and are guided by

* See AMERICAN ENGINEER, April, 1905, pp. 135.



LONGITUDINAL SECTION THROUGH BOILER.

pedestals on the slab frame. The weight is transferred to the boxes through roller bearings.

The brake cylinder has been placed in front of the cylinders and operates a push rod passing through a cored passage in the saddle and connecting to an upright arm on the brake shaft.

The construction of the boiler is quite clearly shown in the illustrations and is especially notable for its unusual depth of firebox, particularly at the throat sheet. It will also be noticed that three 2-in. openings have been provided through each of the side water legs just above the level of the fire. These will admit considerable air from the outside and tend to improve combustion. A firebrick arch supported on four water tubes is to be installed. A single fire door 18 in. in diameter is provided. The boiler contains 268 2¼-in. tubes 19 ft. long, which give a heating surface of about 3,000 sq. ft., which together with the firebox and water tubes give a total heating surface of 3,200, or 70 sq. ft. per square foot of grate area. The ratio of 358 sq. ft. of heating surface per cubic foot volume equivalent simple cylinders indicates that the boiler should easily furnish sufficient steam to develop the full capacity of the engine at high speed.

The general weights, dimensions and ratios are as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Bit. Coal
Tractive effort	22,200 lbs.
Weight in working order	205,350 lbs.
Weight on drivers	107,550 lbs.
Weight on leading truck	52,000 lbs.
Weight on trailing truck	45,800 lbs.
Weight of engine and tender in working order	340,000 lbs.
Wheel base, driving	7 ft. 6 in.
Wheel base, total	32 ft. 2 in.
Wheel base, engine and tender	63 ft. ½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.85
Total weight ÷ tractive effort	9.25
Tractive effort x diam. drivers ÷ heating surface	590.00
Total heating surface ÷ grate area	70.00
Firebox heating surface ÷ total heating surface, per cent	5.73
Weight on drivers ÷ total heating surface	33.50
Total weight ÷ total heating surface	64.50
Volume equiv. simple cylinders, cu. ft.	8.90
Total heating surface ÷ vol. cylinders	358.00
Grate area ÷ vol. cylinders	5.15

CYLINDERS.

Kind	Bal. Compound
Diameter and stroke	15 & 25 x 28 in.
Kind of valves	Piston
Diameter of valves	15 in.

WHEELS.

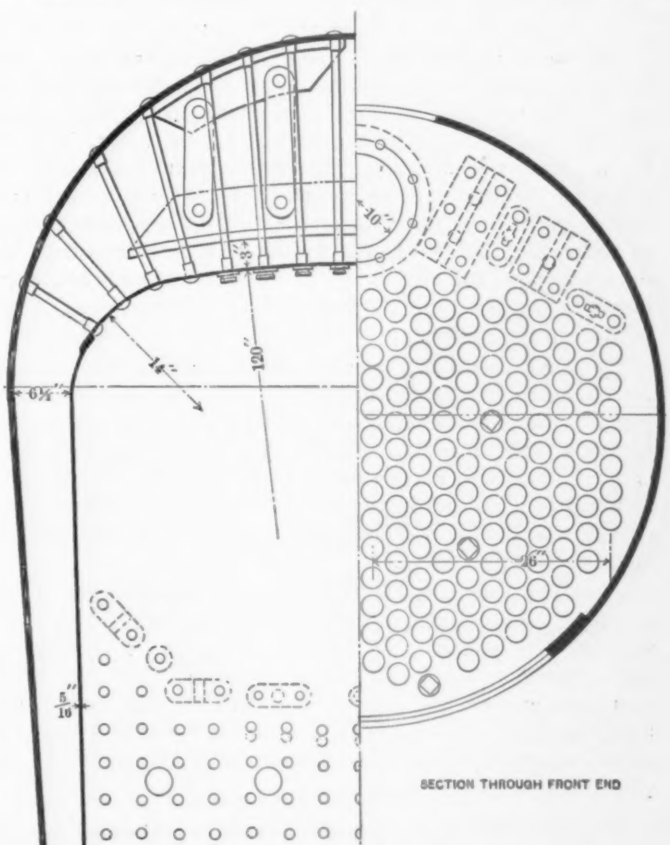
Driving, diameter over tires	85 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10 x 11 in.
Driving journals, others, diameter and length	9 x 12 in.
Engine truck wheels, diameter	36 in.
Engine truck journals	6 x 10 in.
Trailing truck wheels, diameter	49 in.
Trailing truck, journals	8½ x 14 in.

BOILER.

Style	Wagon Top
Working pressure	220 lbs.
Outside diameter of first ring	66 in.
Firebox, length and width	108 x 60⅛ in.
Firebox plates, thickness	5/16, ⅜ & ½ in.
Firebox, water space	F.-4, S. & B.-3½ in.
Tubes, number and outside diameter	268—2¼ in.
Tubes, length	19 ft.
Heating surface, tubes	3,015 sq. ft.
Heating surface, firebox	155 sq. ft.
Heating surface, arch tubes	28 sq. ft.
Heating surface, total	3,198 sq. ft.
Grate area	45.8 sq. ft.

TENDER.

Wheels, diameter	38 in.
Journals, diameter and length	5 x 9 in.
Water capacity	7,000 gals.
Coal capacity	14 tons.



SECTIONS THROUGH FIREBOX AND FRONT END OF BOILER.

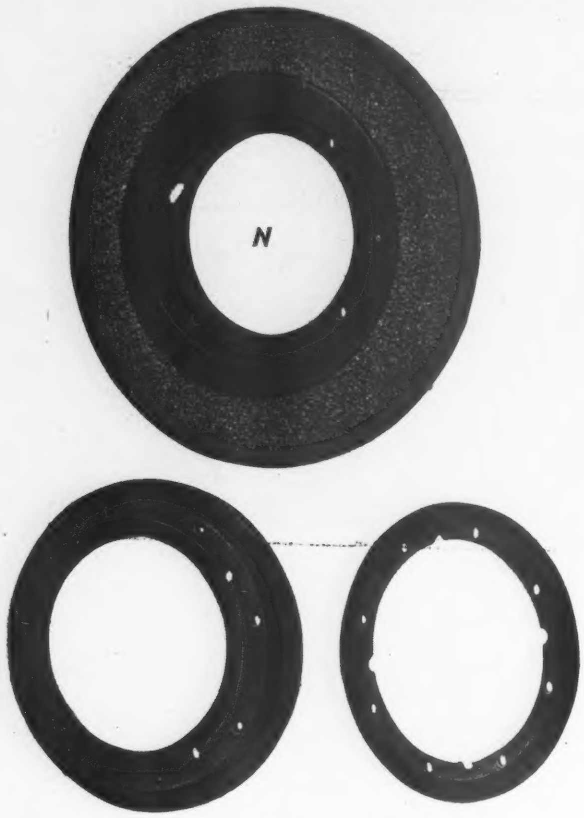


FIG. 2. CLAMP FOR GRINDING WHEEL.

MONARCH CLAMPS FOR GRINDING WHEELS.

The emery and corundum wheels which are made by either the vitrified process, semi-vitrified or silicate process, and the elastic process, by the Monarch Emery & Corundum Wheel Company of Camden, N. J., are furnished in a great variety of shapes for use with the different makes and classes of grinding machines on the market. The two types of clamps illustrated were made especially for use with certain lines of grinding machines to replace the old method of cementing and yet not change the construction of the machine. They hold the wheels firmly and eliminate the annoyance caused by the loosening of wheels cemented on the spindle.

The clamp shown in Fig. 1 is used with a 24 x 2¾ in. wheel for the Sellers No. 1 tool grinder. The clamp consists of three parts. That portion which is recessed to fit the end of the spindle is held securely in place by a nut. The grinding wheel is slipped over this portion of the clamp and the loose flange is mounted in place and is secured in position by a lock nut. To change wheels it is only necessary to loosen the lock nut and take off the loose flange.

The clamp shown in Fig. 2 is used with a Sellers No. 2 universal tool grinder and is fastened to a disc on the end of the spindle. The main part of the clamp is recessed to fit this disc and is bolted to it. It is then only necessary to slip the wheel on to this part of the clamp and to fasten the removable rim or flange in place with set screws. To change the wheels this loose rim is loosened up and a new wheel put in place.

Output of Baldwin Locomotive Works.—The output of the Baldwin Works for the year 1907 exceeds the previous year by 84 and reaches a total of 2,750 locomotives.

Conditions Improving.—"Within a day or two we have received very decided indications that affairs are returning to a more normal condition. It looks as if the railroads are again about to place considerable new equipment orders, which they have not been doing for several months."—*Mr. A. B. Johnson on December 28.*

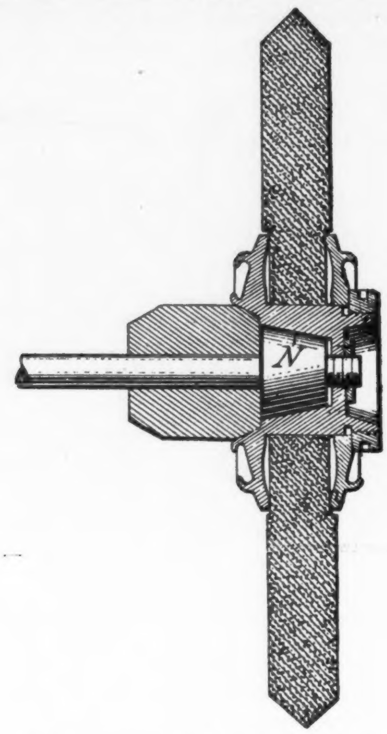


FIG. I. CLAMP FOR GRINDING WHEEL.

PERSONALS

Mr. C. F. Stevens has been appointed storekeeper of the Tonopah & Goldfield Ry., with office at Tonopah, Nev.

Mr. G. S. McKennon has been appointed assistant master mechanic of the Canadian Northern Ry. at Winnipeg, Man.

Mr. C. B. Gifford, master mechanic of the Louisville & Nashville R. R. at Mobile, Ala., has resigned, to retire from railroad business.

Mr. N. L. Smitham has been appointed master mechanic of the Texas Midland Ry. at Terrell, Texas, succeeding Mr. O. W. Lewis, resigned.

Mr. H. A. Rouse, storekeeper of the Chicago & Alton R. R., has had his jurisdiction extended to include the Toledo, St. Louis & Western Ry.

Mr. D. D. Briggs has been appointed master mechanic of the Louisville & Nashville R. R. at Mobile, Ala., succeeding Mr. C. B. Gifford, resigned.

Mr. J. P. Jackson, professor of electrical engineering, Pennsylvania State College, has been appointed dean of the School of Engineering at the same place.

Mr. O. M. Foster, assistant master mechanic of the Lake Shore & Michigan Southern Ry. at Elkhart, Ind., has been promoted to master mechanic at the same point.

Mr. A. O. Berry, general foreman of the Collinwood shops of the Lake Shore & Michigan Southern Ry., has been appointed superintendent of shops at Elkhart, Ind.

Mr. T. O. Sechrist, master mechanic of the Alabama Great Southern Ry. at Chattanooga, Tenn., has been transferred to Somerset, Ky., vice Mr. Dooley, transferred.

Mr. A. R. Ayres, superintendent of shops of the Lake Shore and Michigan Southern Ry. at Elkhart, Ind., has been appointed assistant superintendent of shops at Collinwood, O.

Mr. F. R. Doxey has been appointed master mechanic of the Des Moines, Iowa Falls & Northern R. R. at Iowa Falls, Ia.

Mr. F. W. Schultz has been appointed master mechanic of the Missouri Pacific Ry. and St. Louis, Iron Mountain & Southern Ry. at McGehee, Ark., in place of Mr. I. T. Johns, resigned.

Mr. J. T. Carroll, assistant superintendent of shops of the Lake Shore & Michigan Southern Railway at Collinwood, O., has been appointed assistant master mechanic at Elkhart, Ind.

Mr. Chandler C. Coats, who was master mechanic of the New York & Philadelphia division of the Pennsylvania Railroad for 40 years, died at his home in Newark, N. J., December 2, aged 82 years.

Mr. J. L. Kendrick has been promoted to the position of foreman of the mechanical department of the Buffalo, Rochester & Pittsburg Railway at Punxsutawney, Pa., succeeding Mr. W. H. Williams, promoted.

Mr. J. Quigby, general foreman of the Somerset shops of the Alabama Great Southern Ry., has been promoted to master mechanic of the Chattanooga division at Chattanooga, Tenn., vice Mr. Sechrist, transferred.

Mr. W. H. Williams has been appointed master mechanic of the Buffalo & Rochester division of the Buffalo, Rochester & Pittsburg R. R., with headquarters at East Salamanca, N. Y., vice Mr. H. C. Woodbridge, transferred.

Mr. Charles P. Matthews, professor of electrical engineering at Purdue University, died at Phoenix, Ariz., November 23, 1907, age 40 years. Professor Matthews was widely known for his researches in photometric standards for arc lamps.

Mr. M. J. McCarthy, master mechanic of the Lake Shore & Michigan Southern Ry. at Elkhart, Ind., has been appointed master mechanic of the new Beach Grove shops of the Cleveland, Cincinnati, Chicago & St. Louis Ry., near Indianapolis, Ind.

Mr. William Walter, formerly master mechanic of the Chicago, Milwaukee & St. Paul Ry. at Dubuque, Iowa, has been appointed master mechanic of one of the new divisions of the extension to the Pacific coast, with headquarters at Mobridge, S. D.

Mr. Sanford G. Scarritt, president of the Scarritt-Comstock Furniture Co. of St. Louis died on December 7, 1907. Mr. Scarritt was one of the founders of this company and was treasurer of the St. Louis Railroad Club for many years. He was formerly for many years connected with Mr. N. M. Forney in the development of car seats.

Mr. Storm Bull, professor of steam engineering in the University of Wisconsin, Madison, Wis., died November 18. Prof. Bull was born at Bergen, Norway, October 20, 1856, and was graduated from the Federal Swiss Polytechnic Institute at Zurich with the degree of Mechanical Engineering in 1877. He came to this country, and in 1879 became an instructor in mechanical engineering at the University of Wisconsin. In 1884 he became assistant professor, and in 1886 was made professor of mechanical engineering. He held this position until 1890, when he was appointed professor of steam engineering.

BOOKS

Tests of Reinforced Concrete. Bulletin No. 14, series of 1906, published and issued by the University of Illinois, Engineering Experiment Station. L. P. Breckenridge, Director, Urbana, Ill.

This bulletin describes tests made as a continuation of those described in bulletin No. 4. The topics investigated include the effect of the quality of concrete upon the strength of beams and the effect of repetitive loading and the resistance to diagonal tension failures.

Old Steam Boat Days on the Hudson. By David Buckman. Cloth. 5½ x 8. 136 pages. Illustrated. Published by the Grafton Press, 70 Fifth Avenue, New York. Price, $1.25 net.

The approaching dual celebration of the ter-centennial of the discovery of the Hudson River and the centennial of Fulton's application of steam to navigation on the same river, has led to the incorporation of many interesting stories of the early steamboat days on the Hudson River into one volume. It is very profusely illustrated with views of the early steam crafts, as well as the floating palaces which are now in operation.

Mechanical World Pocket Diary and Year Book for 1908. Pocket size. 4¼ x 6¼. 296 pages. Published by Emott & Co., Ltd., 65 King Street, Manchester, England. Price, 15c., net.

This is the twenty-first year of publication of this well-known pocket diary and year book, which is filled with useful engineering notes, rules, tables and data. It has been completely revised and new sections introduced, old ones re-written and the whole matter brought strictly up to date. The section on electrical transmission of power has been omitted and is being incorporated in another book of similar shape. About 60 blank pages arranged with the days for the year 1908, which can be used for a memorandum and diary, are included.

Proceedings of the International Railroad Master Blacksmiths' Association. Fifteenth Annual Convention, 1907. Edited by A. L. Woodworth. Cloth. 6 x 8 in. 244 pages. Published by the Association, A. L. Woodworth, Secretary, Lima, Ohio.

The 1907 convention of this Association, held in Montreal, Canada, Aug. 21-23, was taken up by the consideration of the usual number of valuable reports and papers. The following subjects were discussed: Tools and Formers for Bulldozers and Steam Hammers; Discipline and Classification of Work; Flue Welding; Case Hardening; Fuel; Piece Work; Frame Making; Thermit Welding and Patch Bolts. A number of the most valuable reports presented at former conventions are reprinted in this volume. The next convention will be held in Cincinnati.

Railway Shop Up to Date. Compiled by the Editorial Staff of the *Railway Master Mechanic*. Maham H. Haig managing editor, and B. W. Benedict, editor. Cloth. 9 x 12. 243 pages. Published by the Crandall Publishing Company, Security Building, Chicago. Price, $4.00.

While the location of the buildings or arrangement of machine tools of a large railway repair shop can never be reduced to a standard, nor is it possible to design the different structures by the unit system, so as to be applicable to shops of all capacities, still what has already been constructed is often of great benefit in deciding upon the best arrangement and design of a new shop. It is also true that while a certain form of structure and interrelation of different departments is perfectly successful in one locality and with one kind of labor, it will not be at all successful under other circumstances. Nevertheless, it is often possible, with slight modifications, to so adapt an arrangement, which is subject to conditions similar to those holding at the place under consideration, that it will be perfectly satisfactory. It is for the purpose of making such information easily available that this book has been compiled, and while practically all of the matter contained therein has appeared in one or more of the technical journals at various times during the past six or eight years, this is the first attempt that has been made, on a large scale, to collect it within one volume.

The work confines itself to the physical characteristics of railway repair shops and opens with a discussion of the layout of a plant, in which the general governing conditions are briefly discussed, each structure being taken up separately. This is followed by a brief investigation of quite a large number of individual repair plants, including both locomotive and car shops.

Line drawings showing the general layout of twenty-one representative shops, either rebuilt or newly constructed during the past ten years, complete the chapter. The remaining chapters take up the different individual shops in the plant, giving first a general discussion of the subject with an investigation of the advantages and disadvantages of various arrangements and construction, which in each case is followed by illustrations of the buildings devoted to these purposes at a large number of plants. Such chapters include the locomotive shop, in which is given the layout of the machine tools and machine tool list for several shops; the blacksmith shop; freight car shop; coach and paint shop; planing mill; foundry; power plant; store-house and roundhouse, including coal and ash-handling plants.

The book is concluded by a list of references to shop descriptions which have appeared in the various technical journals since 1900. A comprehensive and complete index is included.

The Car Wheel. Giving the Results of a Series of Investigations by Mr. Geo. L. Fowler, M. E. Bound in boards; 5 x 9; 161 pages; illustrated. Published for private distribution by the Schoen Steel Wheel Company, Pittsburg, Pa.

While president of the Pressed Steel Car Company, Mr. Chas. T. Schoen was confronted with the difficult problem of obtaining wheels which would meet the requirements of 100,000-lb. capacity cars, particularly on mountain roads with steep grades and sharp curves. The situation was so serious that for a while it seemed as if it was going to be impossible to operate cars of this capacity except in special cases, owing to the fact that the failures of cast iron wheels were so numerous. Mr. Schoen decided that the requirements demanded something better than even a much improved cast iron wheel and that it would be absolutely necessary to use some kind of steel wheels under high capacity freight cars, as well as passenger coaches, if the full benefit of this equipment was to be obtained. The cost of the steel tired wheels made them prohibitive for this service and hence attention was turned to the developing of a solid forged and rolled steel wheel. The first of these wheels were designed in 1901, and in 1903 the business was established on a commercial basis. Since that time the enterprise has been a success and at present this company has a plant in operation in this country capable of producing 250,000 wheels per year, as well as a plant in England with a capacity of 100,000 wheels.

Actuated by a desire to know exactly what were the requirements to be met by car wheels in the most difficult service, this company retained Mr. George L. Fowler, consulting mechanical engineer, New York, to make a complete investigation of the stresses occurring in car wheels, particularly at the flange, as well as the quantity of metal and workmanship necessary to give a satisfactory wheel, both in regard to strength and wearing qualities. This work has been carried out very carefully and results have been obtained which will be of great benefit to the railways. These are now given publicity through the medium of this book.

Most of the tests made are comparative between solid forged and rolled steel wheels, steel tired and cast iron wheels. All of the tests were made upon wheels bought in the open market, chosen at random and tested under identical conditions. These investigations covered a period of over two years and tests and studies were made on the lateral thrust of wheels against the rail, the comparative physical and chemical properties of the material, the heat treatment and penetration of physical work in rolling the metal and co-efficient of friction between the wheel and rail, both sliding and slipping. The report of each test is very complete, the methods used and results obtained being clearly explained, tables being put into graphical form wherever possible. The illustrations are reproduced on heavy plate paper and pasted on blank pages of the book, and give results as good or better than actual photographs. The results are presented impartially and the value of the data given cannot be exaggerated.

The book itself is an excellent example of the bookmaker's art, being printed on heavy vellum paper with illuminated chapter headings. It is bound in boards with embossed gold title letters.

CATALOGS

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

THERMIT WELDING.—The Goldschmidt Thermit Co., 90 West street, New York, is issuing a reprint, from the journal of the U. S. Artillery, of an article on the possibilities of quick repairs on heavy ordnance by thermit welding processes. A number of excellent illustrations, showing the possibilities of this compound for use on ordnance and steamship work are included.

GRE-SOLVENT.—The Utility Company, 636 West 44th street, New York City, has furnished samples of a paste compound manufactured by it and known as "Gre-solvent." Will quickly dissolve and remove from the hands all manner of machine grease, grime, paint, printers' ink, etc. Is said not to injure the most sensitive skin and to be practically as cheap as soap. It is understood that free samples will be mailed on request.

GRINDING WHEELS AND MACHINERY.—The Norton Co., Worcester, Mass., is issuing a small catalog which includes a table showing the grade of grinding wheels required for different kinds of work. These are manufactured of alundum in twenty-six different grades, each of which is adapted to special purposes. Illustrations and brief descriptions of a few grinding machines and a price list of wheels are included.

MACHINE TOOLS.—Catalog No. 45 from the Newton Machine Tool Works, Philadelphia, Pa., illustrates and briefly describes their general line of machine tools. It contains over 300 pages, is 6 by 9 in. in size and is neatly and substantially bound in cloth. The machines described cover the following lines: milling machines, boring machines, cold saw cutting off machines, drilling machines, shaping machines, crank planers, gear cutting machines, nut machines, rotary planing machines, also a number of miscellaneous machines.

PIPE AND BOILER LAGGING.—The Philip Carey Co., Cincinnati, O., is issuing an attractive catalog entitled "Carey's Coverings." This illustrates many different types of coverings for steam and air pipes, magnesia boiler lagging, magnesia cement, mineral wool, hair felt, asbestos products, etc. Many excellent photographs of installations are also included. The covering for steam pipes and boilers are absolutely fireproof and the most thorough non-conductors of heat. These laggings are light in weight and are furnished in sizes and shapes to suit any requirements.

ELECTRICAL APPARATUS.—The General Electric Company is issuing a number of new bulletins describing the latest improvements in several of its different products. One of these is on the subject of portable instruments, which are claimed to be permanently accurate and capable of giving accurate indications in the vicinity of external magnetic fields. Another bulletin covers single phase motors of moderate capacities. It illustrates various sizes, describes the details of construction and operation, shows forms of starting boxes and gives a large amount of general information useful and important to power users. These motors are well adapted to the operation of all kinds of machines and may be direct connected to loads requiring a moderate starting torque. Other bulletins are being issued on the subject of meter testing, direct current instruments, and concentric and inverted diffusers.

SPEED INDICATOR.—Harry Vissering, Chicago, is issuing an attractive catalog illustrating the Hausshalter speed, time and distance indicator and recorder. This apparatus is adapted for use on locomotives or cars and in addition to indicating the speed of the train by means of a hand on the dial, it also automatically records on a record tape the speed at all times, the time between stops, time of stops, distance of stops from terminal, time and rate of accelerating or retarding, distance between stations or stops, total distance and time of run. This record, as can easily be seen, would prove of great value to the transportation department. The record tape is located within the case of the instrument and can only be removed by the proper authority. The construction and arrangement of the apparatus is clearly explained by many line drawings, halftone views and carefuly written type matter. Sample record tapes and illustrations of the proper method of attaching the instrument to the locomotive or car are included. This instrument will do all that the Boyer speed recorder will and gives many other valuable records in addition.

NOTES

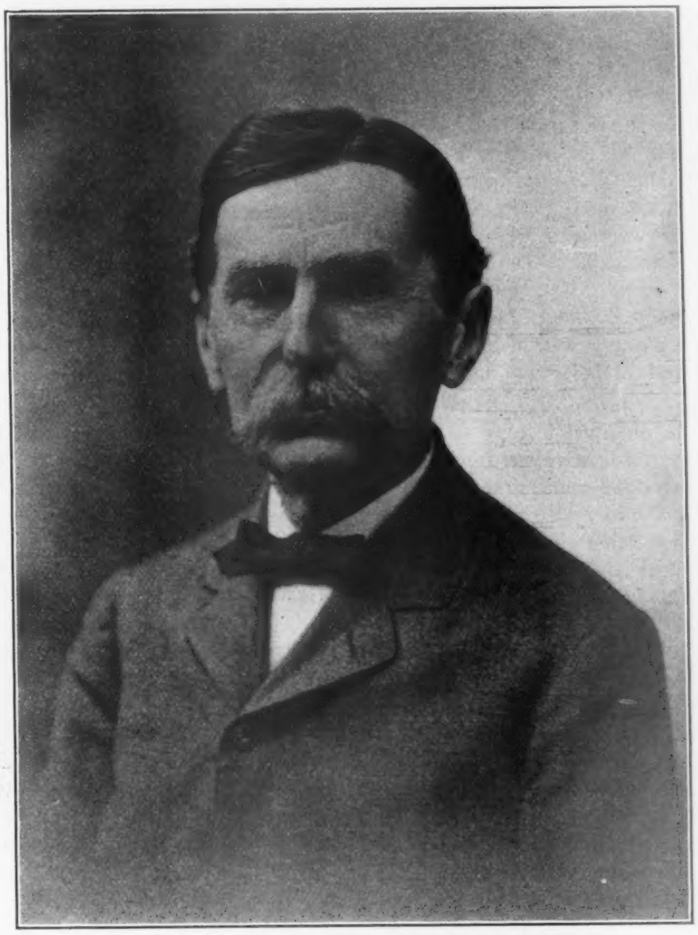
REFINED IRON & STEEL COMPANY.—This company announces that it has not been compelled to close down its mill because of the financial stringency as has been found necessary with a number of other plants in the Pittsburg district, but that on the contrary it has been compelled to run double turn in its finishing mills for several weeks.

AMERICAN LOCOMOTIVE COMPANY.—Among the orders recently received by this company are three consolidation locomotives for the Western Railway of Havana, cylinders 20 x 24 in.; two Mogul locomotives for the Northwestern Pacific Railway, cylinders 18 x 24, and five ten wheel locomotives for L. J. Smith, with 19 x 28 in. cylinders.

MATTHIAS NACE FORNEY.

Matthias Nace Forney died Tuesday, January 14, at the Hotel Buckingham, New York City, after a first attack of paralysis. He was buried at Hanover, Pa.

Very few men have exerted so great an influence on the upbuilding of our railroads, and none more than Mr. Forney. A large part of his most important and effective work was done a generation ago and it is impossible to realize fully the far-reaching importance of some of it without understanding the conditions as they then existed. In the "battle of the gauges," in the early seventies, Mr. Forney, at that time editor of the *Railroad Gazette*, fought almost alone, at the beginning, against the general adoption of the narrow gauge and was finally successful in turning the tide. He was very active in the Master Car Builders' and Master Mechanics' Associations; the reorganization of the Master Car Builders' Association, placing it on a representative basis, for which he was largely responsible, has resulted in the standardizing of freight equipment so that cars may be interchanged over the railroads on the continent. He was active in advocating the adoption of elevated railways in New York City and for many years the Forney type locomotive was used exclusively on these roads, prior to the adoption of electricity. He was largely instrumental in gathering together and arranging the information in the first editions of the Master Car Builders' Dictionary. It is impossible to estimate the influence of his clear-cut, far-sighted, common-sense views advanced in connection with his journalistic work, when technical journalism was in its infancy; nor can the far-reaching results of such a work as his "Locomotive Catechism" be computed.



M. N. Forney

His character can best be summed up in a paragraph taken from an editorial notice in the *Railroad Gazette*, written by Mr. S. W. Dunning, who was associated with him for many years on that paper:

"To us who knew Mr. Forney intimately, the character of the man overshadows all accomplishments and performances. He not only did justly, but he was willing to spend and be spent that justice might be done. He loved mercy, and he labored that the weak and helpless should be mercifully dealt with. In the later years of his life he gave a great deal of work and was at considerable expense to secure better treatment of horses—creatures with which personally he had little more to do than with elephants. Believing that material political progress is to be hoped for from minority representation he published at his own expense a book on the subject, containing, with much else, the substance of other works then out of print. In many similar ways he demonstrated his public spirit, his humanity and his unselfishness. No one could more truly say: *'Write me as one who loves his fellow-men.'*"

Mr. Forney was born in Hanover, York Co., Pennsylvania, on March 28, 1835. His father, after whom he was named, died March 25, 1857, leaving his mother with the care of three sons and three daughters.

The schools in Hanover in those days were taught by teachers of more or less itinerate habit, and in the words of Mr. Forney "knowledge had to be assimilated from much indigestible food." He had this to say of his early life: "Very early in life mechanism and science interested me very much. It gave me great pleasure to decorate the top of our woodshed with miniature wind-mills, to construct water-wheels which were driven by the stream from a spring near the house, and to make toy cannons out of anything which would hold a charge of powder. My great ambition was to build a small steam engine, but for that my mechanical resources were not adequate, although I made a number of attempts in that direction. Tools and machinery were my delight then, and have been ever since. I then always had a workshop which was very poorly equipped with carpenter's tools, but it was a source of endless pleasure to me. My first ambition was to be a shipbuilder, then steam-engines took hold of my imagination and finally locomotives got possession of me and have absorbed much of my time and thoughts ever since."

At fourteen years of age he was sent to a boys' school in Baltimore, where he remained for three winters. In April, 1852, he entered the shop of Ross Winans as an apprentice. Mr. Winans was then engaged in building locomotives in Baltimore, chiefly for the Baltimore & Ohio Railroad. Three years were spent in the shop and one in the drawing room. His next position was that of draftsman in the shops of the Baltimore & Ohio Railroad, where he continued for about three years. As the prospect of advancement did not seem very good he entered the mercantile business in about 1858, where he remained until the outbreak of the civil war in 1861.

His business ventures up to that time had not been successful. Business in Baltimore was more or less disturbed, and after trying several different occupations he took a position as draftsman in the machinery department of the Illinois Central Railroad in Chicago. It was while in this position that he designed what afterwards became known as the "Forney engine," but because of delays in the patent office the patent was not issued until 1866. He remained with the Illinois Central for about three years, after which he took a position for a short time as draftsman with the Detroit Bridge & Iron Works. In the spring of 1865 he received an appointment from the president of the Illinois Central Railroad Company to superintend the building of some locomotives at the Hinckley & Williams Works in Boston. This work occu-

pied about six months, after which he entered the employ of Hinckley & Williams, partly as a draftsman and partly as a traveling agent. He remained with them about three years. During the last year of that time his office and headquarters were in New York and when his engagement with the company was ended he spent a year or more in futile attempts to make a living by office and other work.

In the fall of 1870 he became associate editor of the *Railroad Gazette*, which was then published in Chicago. In 1871, the year of the great fire, the publication office was removed to New York and shortly afterward Mr. Forney and S. W. Dunning, who was then editor-in-chief, bought the paper, each owning half. Mr. Forney looked after the engineering and mechanical matters and Mr. Dunning had charge of the transportation and traffic department and general railroad news.

In 1870 Robert Fairlie presented a paper before the British Association advocating the adoption of the narrow gauge for railroads, in place of the wider gauges then in use. It was contended that the use of the three-foot gauge would reduce the expense of building and equipping a road in a ratio of about 3 ft. to 4 ft. 9½ in. Difficulty was being met, especially in the western portions of this country, in building and operating new roads and this promise of reduced costs immediately attracted widespread attention. Mr. Forney, single-handed and alone at the beginning, opposed the adoption of the narrow gauge, although practically all of the technical papers, including such authorities as *The Engineer* of London and *London Engineering*, were advocating it. The systematic campaign which he waged and the forcible way in which he presented the facts at his command and combated his opponents, often exposing the fallacy of their arguments by ridicule, undoubtedly kept the craze from reaching serious proportions. Mr. Forney was also very active in advocating the adoption of standard bolts and nuts.

His account of how he came to write the "Locomotive Catechism" is as follows: "In 1873 we obtained a copy of George Kosak's excellent little book on the locomotive, written in German. Mr. Dunning, who reads that language, agreed to translate the book and proposed that I should revise and adapt it to American practice, and that the translation should then be published serially in the *Railroad Gazette* and in book form thereafter. The translation was made and submitted to me for revision and adaptation, according to the original intention. Before that I had planned and had commenced writing an elementary treatise on the locomotive. In revising the first chapter of the translation of Mr. Kosak's book, it was found that it occupied only, to a very limited extent, the ground which in my incomplete plan I hoped to cover. Therefore the original intention of 'adapting' Mr. Kosak's work was abandoned, and the whole book was rewritten and published in book form thereafter. In writing it, the aim was to explain the principles, construction and operation of locomotives in the simplest and clearest language possible, so as to be easily comprehended by engineers, mechanics, firemen and apprentices who have had few educational advantages. The only mathematics employed, excepting simple arithmetic, was one algebraic formula, and that might have been omitted. The book seemed to supply a need, and at once had a large sale, which has continued ever since. It was rewritten and enlarged in 1889, and the demand for the revised edition still continues."

In the early seventies, before any system of transit more rapid than horse cars existed in New York, the traffic was seriously obstructed by each severe snow storm during the winter. A great many projects were proposed for alleviating this condition and in 1874 the American Society of Civil Engineers, of which Mr. Forney was a member, appointed a committee to investigate conditions and recommend plans for the best means of rapid transit for passenger service and the best and cheapest methods of delivering, storing and distributing goods and freight in and about the city of New York. Mr. Forney and Mr. Octave Chanute, then chief engineer of the Erie Railroad, had most of the work in preparing the report, which without doubt had much influence in bringing about the enactment of a rapid transit act under which the existing elevated roads were built. The problem of motive power for the elevated roads was successfully solved by the use of the Forney type locomotive and these were used exclusively on New York and Chicago elevated roads until superseded by electric power.

In 1872 Mr. Forney became an associate member of the American Railway Master Mechanics' Association and in 1873 of the Master Car Builders' Association. At that time no direct relationship existed between the railroads and the Master Car Builders' Association and it soon became evident to Mr. Forney that the field of usefulness of the Association could be greatly extended by giving the railroad companies a representation in its deliberations. After much discussion and many reports the Association was reorganized and placed on its present basis. The effect of this change soon became apparent and the influence of the Association has steadily increased since that time. After the reorganization Mr. Forney was appointed secretary of the Association, which position he held until 1899, when because of the pressure of other duties he asked to be relieved.

The following extracts are taken from a report of a committee (1889), consisting of Messrs. E. B. Wall, Godfrey W. Rhodes and J. S. Lentz, "appointed to express the appreciation of the Association for the services and character of M. N. Forney, ex-secretary":

"The Master Car Builders' Association is under greater obligations to Mr. M. N. Forney than to any other one man for its elevation to the position of confidence and usefulness it now holds in the railway world."

"Mr. Forney, as an associate member contributed much useful information to the Association, but the great work with which he was most prominently identified was the reorganization of the Association in 1882. By this reorganization the railways became directly and officially represented in the work of the Association, and its sphere of usefulness was greatly enlarged."

"It was most fortunate to the railway companies that there was at that time a man possessing their confidence, by reason of his technical attainments and solidity of character, who could disinterestedly set about this work."

"After the reorganization was effected, the Association was fortunate in retaining the services of Mr. Forney as secretary. His work since then has been characterized by patient enthusiasm, painstaking care in the discharge of his duties, and an insistence for technical correctness which has contributed very greatly to the value of the recommendations of the Association."

In 1871 a committee of the Master Car Builders' Association was appointed to prepare a "dictionary of terms used in car building." This committee was too large and it finally narrowed down to three members, Mr. Forney doing the writing and Leander Garey and Calvin Smith acting as consulting members of the committee. After several years of hard work the "dictionary" was completed and in 1879 it was published by the *Railroad Gazette*.

Messrs. Forney and Dunning continued to publish the *Railroad Gazette* until the end of 1883 when Mr. Forney sold his interest to W. H. Boardman, who had been business manager of the paper for several years. For three years following this he was not engaged in any regular business, but this soon became wearisome and in the latter part of 1886 he bought the *American Railroad Journal* and *Van Nostrand's Engineering Magazine*, and on the first of January, 1887, consolidated these two publications under the name of *The Railroad and Engineering Journal*. This he published and edited until the end of 1895, changing the name, however, in 1893 to the *American Engineer and Railroad Journal*. On January 1, 1896, he sold his interest in it to R. M. Van Arsdale, the proprietor of the *National Car and Locomotive Builder*, who then consolidated the two publications. Part of the agreement in making the sale was that Mr. Forney should edit the new paper for one year; in this he was assisted by W. H. Marshall.

Since that time he has not been engaged in any regular business, but has been occupied in a number of different ways and in

a variety of matters. Among other things he has given a great deal of attention to reforming the practice of high-checking horses. He has also worked on the design of a balanced locomotive, his intention being to do away with the crank axle.

He remained a bachelor until 72 years of age and on June 25 of last year was married to Mrs. Annie Virginia Spear of Baltimore, a friend of his youth.

Invention always had a great fascination for Mr. Forney, and in all he was allowed over 30 patents, most of them in connection with improvements to locomotives and cars. While the mechanical development of these various devices proved intensely interesting, the effort required to introduce them was always more or less obnoxious to him and he did not receive any financial returns except from two—the improved tank or Forney type locomotive and a car seat.

He gave much time to the improvement of social and political affairs and was a member of the American Free Trade League and American Peace Society of Boston, the Citizen's Union and Anti-Imperialist League of New York. He was also a member of the Union League, the Century, the Engineers' and the New York Railroad Clubs. In 1898 he was elected an honorary member of the American Railway Master Mechanics' Association and in 1890 was elected a life member of the Master Car Builders' Association. He was one of the organizers of the American Society of Mechanical Engineers; also of the New York Railroad Club.

In addition to the Master Car Builders' "Dictionary" and his "Locomotive Catechism" he wrote two or three books on political subjects, which, however, as far as he could see, did not accomplish any apparent results.

BUILDING WOODEN FREIGHT CARS

CANADIAN PACIFIC RAILWAY*

Synopsis.

Introductory.

The Canadian Pacific Railway has at Angus, Montreal, one of the largest and best operated wooden car building plants, under railroad management, on this continent. Some idea of its importance may be gained from the fact that all of the new freight and passenger cars for the system are built at these shops. During the year ending June 30, 1907, the freight car department built the following equipment:

4,644 Box cars, 30 ton.
18 Refrigerator cars, 38 ft.
200 Stock cars, 30 ton, 36 ft.
361 Flat cars, 40 ton, 41 ft.
782 Flat cars, 30 ton, 36 ft.
254 Hart ballast cars, 40 ton, 34 ft.
4 Derrick cars, eight wheel.
9 Flangers.
9 Snow plows.
38 Refrigerator cars for passenger service.

During the same time the passenger car department built 248 cars as follows:

22 Sleeping cars.
19 Dining cars.
77 First class coaches.
21 Suburban coaches.
24 Colonist cars.
3 Observation cars.
11 Smoking and baggage cars.
19 Baggage cars.
8 Baggage and express cars.
16 Mail and express cars.
1 Official car.
2 Baggage commissariat cars.
25 Box baggage cars (box cars with passenger and baggage car equipment).

The freight car repair yard at Montreal is not included in the Angus shop plant, but is located at Hochelaga, a mile or two distant. Up to the first of last July most of the passenger car repairs were made at the old shops at Hochelaga, only a comparatively few of the heavier repairs being done at the Angus shops. During the year ending June 30, 1907, 41 extra heavy repairs were made at Angus and 16 sleeping and 8 official cars were given general repairs. The capacity of the passenger car shops at Angus is being practically doubled by the addition of new buildings and equipment, and it is the intention to repair, as well as build, all of the passenger cars there from this time on. In addition to the new cars which are built, manufactured material for repairs is supplied to the entire system. The company finds it greatly to its advantage to manufacture and build its equipment both because of the large amount of this work, due to the size of the system and the rapidity with which it is growing, and because of the heavy duty on imported material.

The arrangement, construction and equipment of the locomotive and car shops were described at length in this journal in 1905 and the purpose of the present article will be to consider the organization and operation of that portion of the car department devoted to freight cars, as due to the present extension of the passenger car department the conditions for making a similar study are not as favorable as they will be at a later period. To present this study in a comprehensive manner, and such as will appeal to the reader, the building of a standard box car will be described, starting with the ordering of the raw material and finishing with the car as it is turned over to the operating department. The idea will be not so much to consider each process in detail as to trace the material from start to finish, directing special attention to those features of manufacture or organization which possess special merit.

During part of August and September, 28 of these 30-ton, standard box cars were built for each day of ten hours. This is at the rate of one every 22 minutes, or less, of working time. The car bodies were erected at the rate of one car for every 8⅓ men, every ten hours. It may readily be seen that to accomplish this would require not only good facilities but a splendid organization. On several days a larger number of cars was turned out, the record being 40 for one day. While the detail description of the building of these cars will possibly not appeal to all of our readers, there are certain underlying features or principles which are applicable to all classes of work and are worthy of careful study. Especially noticeable is the co-operation between the vari-

* The Canadian Pacific Railway is a wonderful property. It owns a line extending from the Atlantic to the Pacific oceans with thousands of miles of branch lines. The last annual report gives the grand total mileage as 10,239 miles, including 823 miles under construction. It owns a line of steamers from Quebec to Liverpool and another from Vancouver to Yokohama; also lake and coast steamships. It owns the Dominion Express Company which operates the express business over its lines; also the telegraph lines which serve its territory, and its own parlor and sleeping cars. It owns a controlling interest in two United States lines—the Duluth, South Shore & Atlantic (600 miles) and the Minneapolis, St. Paul & Sault Ste. Marie (2,282 miles). It owns 14,800,000 acres of unoccupied land.

In a letter read before the Canadian parliament last spring Sir Thomas Shaughnessy, president of the company, showed that during the previous 5 years $28,000,000 had been spent on equipment, $44,000,000 on improvements to the existing lines, shops and roundhouses, and $35,000,000 for new lines and new Atlantic steamers. Last year $700,000 was spent on ocean, lake and river steamships, $4,500,000 on construction of new lines, $11,000,000 on additions and improvements, and $13,500,000 on rolling stock, shops and machinery. The gross earnings were $72,200,000, against $61,700,000 in 1906, an increase of 17 per cent. The net earnings were $25,300,000, against $23,000,000 in 1906, an increase of 10 per cent

During the year 5,946,779,961 tons of freight were carried one mile, the average receipts per ton per mile of revenue freight being 0.776 cents. The number of passengers carried (earning revenue) one mile was 1,052,286,316, the average amount received per passenger mile being 1.79 cents.

On June 30, 1907, the rolling stock was as follows: 1,296 locomotives; 1,191 first and second class passenger cars, baggage cars and colonist sleeping cars; 224 first class sleeping, dining and café cars; 51 parlor, official and paymasters' cars; 40,405 freight and cattle cars; 722 conductors' vans; 2,108 board, tool and auxiliary cars and steam shovels.

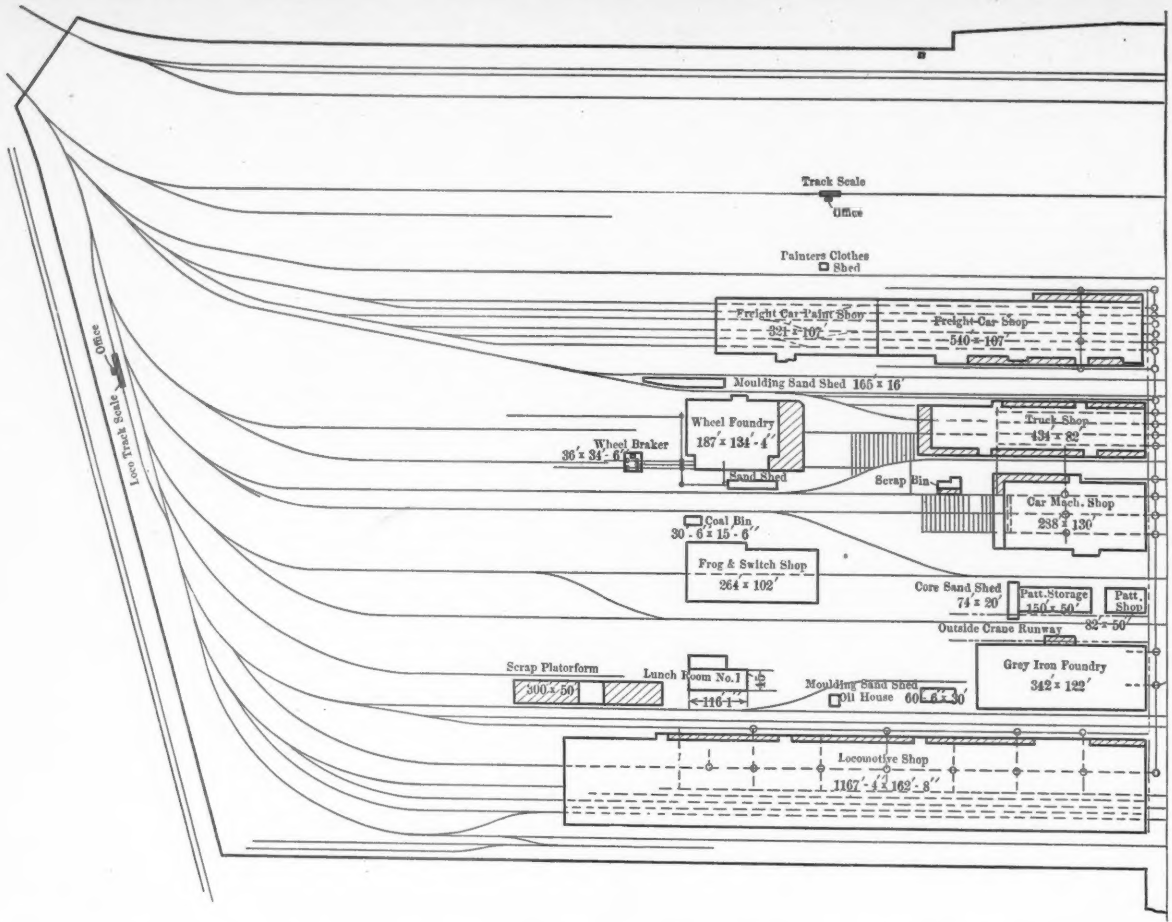


FIG. I.—GENERAL PLAN OF THE ANGUS CAR AND LOCOMOTIVE SHOPS—CANADIAN PACIFIC RAILWAY.

ous departments; the routing of material to keep it moving to its objective point, as directly and with as little re-handling as possible; the simple and orderly arrangement of storing and handling the material; the organization of the erecting gangs in both the truck and car shops, whereby the work is specialized to a high degree and is brought to the men rather than having the men go to the work, thus making each man a part of a large machine and also simplyfying the distribution of material.

As may be seen from a study of the synopsis, the intention is to start from the material yard of the wheel foundry and trace the various operations through the foundry and into the wheel shop until the wheels are mounted on the axle. Leaving them at this point the grey iron foundry and the smith shop will be studied and the material followed from these departments into the car machine shop and thence to the other departments. The next step will be to study the erection of the truck and its movement to the freight car erecting shop. Leaving it here the lumber will be followed from the storage yard through the dry kiln and the planing mill into the erecting shop. The erection of the car body will then be considered in detail, after which it will be followed to the paint shop and thence to the scales, when it will be ready for the operating department.

General Arrangement of the Plant.

A study of the general arrangement of the locomotive and car shops was presented in the December, 1904, issue of this journal, page 451. It will be recalled that this was the largest railroad shop plant ever built and put into service at one time. The arrangement of the various buildings and the facilities provided have proved very satisfactory, but the increasing amount of work, because of the rapid rate at which the system is growing and being extended, has made necessary several additions to the original plant.

The general plan, which is presented herewith, has been revised to date, and by comparing it with the one shown on page 451 of the December, 1904, issue, the additions which have been made will be seen to be as follows: A wing has been added to the southeastern portion of the smith shop and the spring department has been removed to it from the northwestern portion of the building, which is devoted to car department work. When the shops were first installed the new freight cars were painted in the western end of the freight car shop, but it has since been found necessary to provide a separate paint shop by extending the building 321 ft., as shown. The upholstering department has been removed from the second story of the cabinet shop to a new building and a carpet cleaning shed has been erected alongside the upholstering shop. The cabinet shop has been increased in length almost 50 per cent. The transfer table has been extended and a passenger car paint shop has been built on the west side and a new passenger car building shop on the east side. The power house has been extended from 163 to 227 ft. in length and additional power units are being installed.

Organization.

The wheel and grey iron foundries, as may be seen from the accompanying chart, which shows the organization of the freight car department, are under the jurisdiction of the master car builder. The effectiveness of the car department is probably largely due to the broad policy of those in charge, which encourages team work among the foremen and calls forth their best efforts. Each foreman is encouraged to think for himself and plan improvements, and is given all the authority he is individually fitted to assume.

Ordering and Delivery of Material.

When it has been decided by the management to order new equipment the general foreman is instructed to make the proper requisitions. If it is the first order for a piece of equipment the material lists are checked by the drawing room. For succeeding orders it is, of course, not necessary to take this precaution, unless changes have been made in the design. The requisitions, after being O. K.'d by the head of the department, go to the storekeeper. Such material as is to be purchased is then ordered through the purchasing agent.

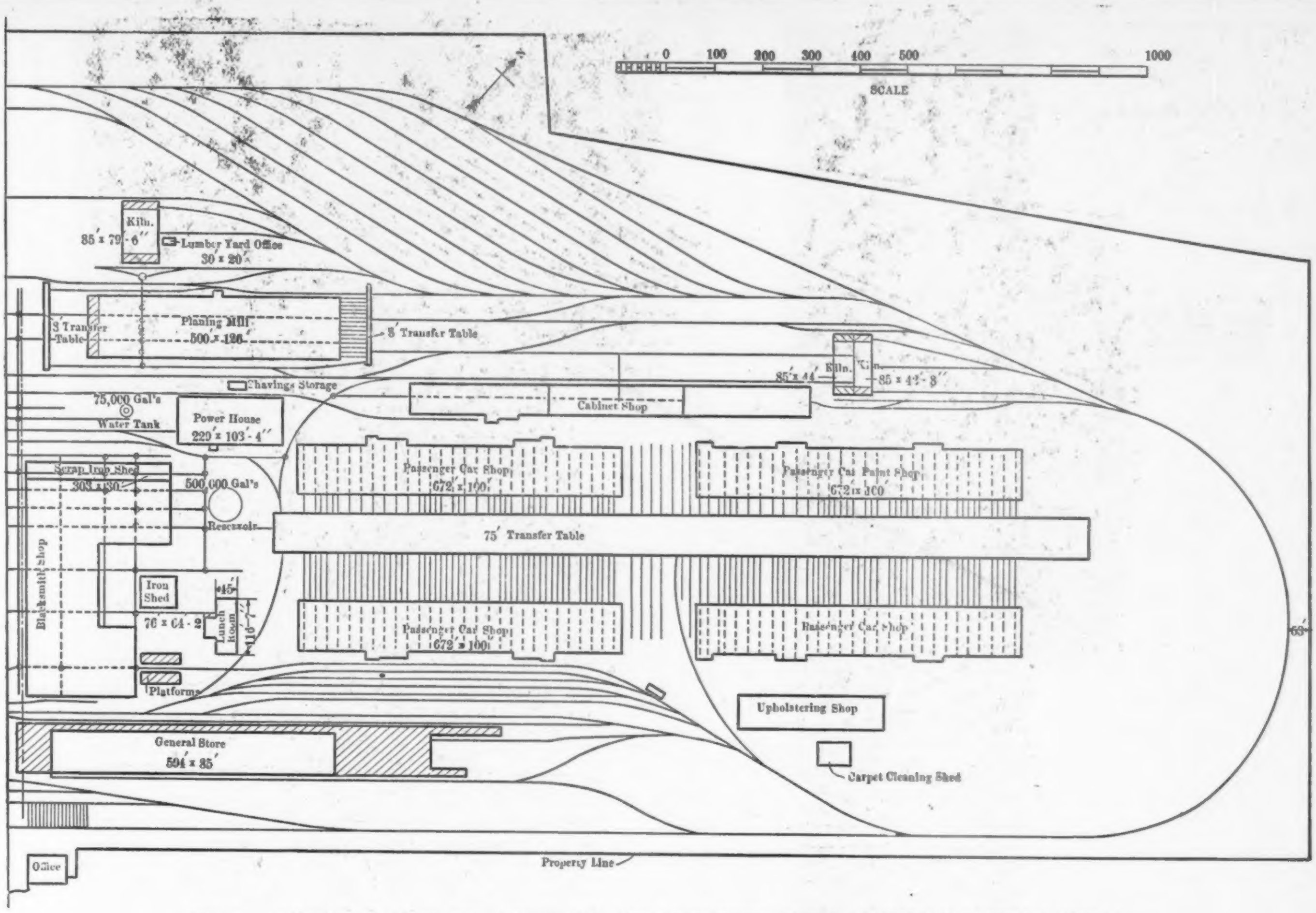


FIG. I.—GENERAL PLAN OF THE ANGUS CAR AND LOCOMOTIVE SHOPS—CANADIAN PACIFIC RAILWAY.

In a plant with the large output of the Angus shops, it is necessary to keep a close check of all material supplied, and yet this must be done in such a manner as not to interfere with the working of the plant in any way. To do this successfully it is necessary for the storekeeper to have a large force scattered over the entire plant, and to make the wheel and grey iron foundries, as well as some of the other departments, practically sub-storehouses. For instance, all of the material that goes into the cupolas is weighed and checked by a storehouse clerk, and the finished castings are also weighed and distributed under the jurisdiction of storehouse employees. The raw material for the blacksmith shop, although stored just outside of the shop, is in charge of the storekeeper's department and is delivered to the blacksmith department on order from the foreman. The lumber is received by the store department and unloaded, checked, and piled in a yard covering 40 acres. The various foremen order their material from the yard and the checkers see that it is properly delivered. Manufactured material, as will be seen, is stored as near as possible to the place where it is to be used, and is in charge of the storehouse department until it is turned over to the foremen for use.

- W. E. Fowler, M. C. B.
  - C. F. Rydberg, Supt. Angus Car Shops.
    - C. G. Halley, Genl. Frt. Car Foreman.
      - C. T. Ridalls, Asst. Genl. Frt. Car Foreman.
      - J. McMoon, Foreman Frt. Car Part of Planing Mill.
      - P. Quinn, Asst. Foreman, Car Erecting Shop.
      - H. Beals, " " " " "
      - P. McCabe, Charge Hand, Truck Erecting Gang.
      - T. Kane, " " Painting Gang.
    - H. R. Marengo, Foreman Car Mach. Shop.
      - H. L. Langlars, Asst. Foreman.
      - John Young, Charge Hand, Truck Machine Shop.
      - Lucian Vogin " " Brass Room.
      - Joseph Allard, " " Drillers.
    - H. Nicholl, Foreman Wheel Foundry.
    - A. E. Smith, " Grey Iron Fdy.
    - D. McIntosh, " Cupola and Cylinder Department (Grey Iron Foundry).
    - W. H. Sleep, " Smith Shop.
    - F. D. Zercher, General Foreman, Passenger Car Department.

ORGANIZATION OF THE FREIGHT CAR DEPARTMENT.

In addition to such checks as the store department may have upon the material the superintendent of the car department keeps an independent check. When a lot of cars are ordered each item is entered in red ink at the head of a column on a large sheet. When the material is received from the store department the foremen issue what is known as a form "M," as a receipt for it. The blanks for these form "M's" are bound in small books, and each one is carefully numbered and a carbon copy of each order issued remains in the book. Each foreman has two books for each order of cars, and every morning sends the one he is not using to the superintendent's office. A clerk in the office enters the various items of material, which have been drawn, in black ink in the proper columns on the large sheets, and it is possible to see at once just what amount of material is still due on each order. This provides a check against the storekeeper and also against the wasting of material.

Wheel Foundry.*

The wheel foundry is located to the southwest of the truck shop with ample storage space between. Raw material for foundry use is stored southwest of the shed containing the wheel breaker and the scales, which is 36 x 34 ft. 6 in. in size. One of the views, Fig. 2, taken from the top of the breaker house, shows the pig iron piled to the left and the scrap wheels to the right, with the delivery track between. The coke is piled to the right of the scrap wheels and some few cars loaded with it are indistinctly shown in the photo. The pig iron is loaded on small

* For a description of the construction of the building see page 4 of the January, 1905, issue. The equipment and its arrangement are described on page 326 of the September, 1905, issue.

FIG. 3.—INTERIOR OF THE SCALE AND BREAKER HOUSE.

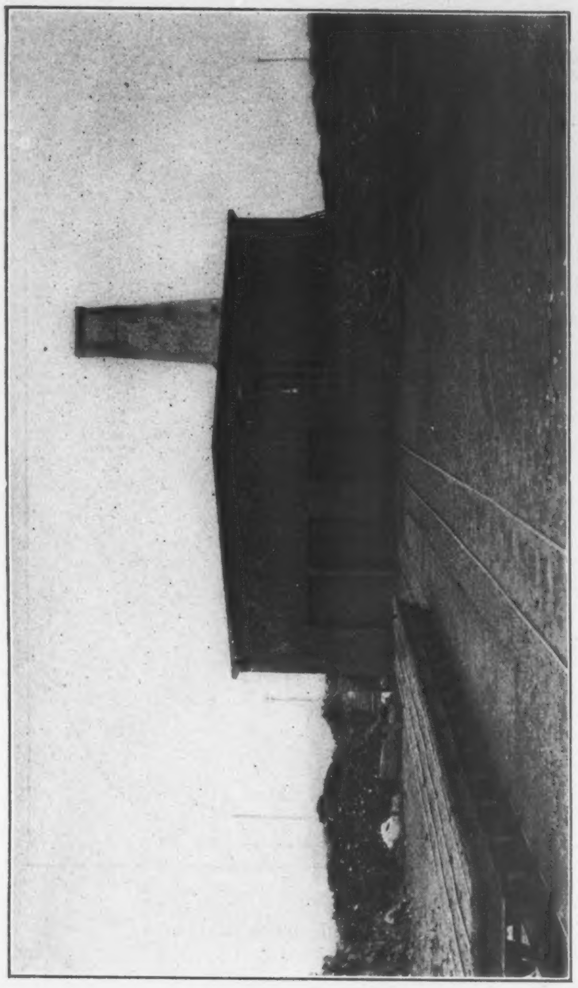


FIG. 4.—SCALE AND BREAKER HOUSE—LOOKING FROM THE END OF THE WHEEL FOUNDRY.

FIG. 2.—VIEW FROM TOP OF SCALE AND BREAKER HOUSE, SHOWING PIG IRON SUPPLIES AT THE LEFT AND SCRAP WHEELS AND COKE AT THE RIGHT.

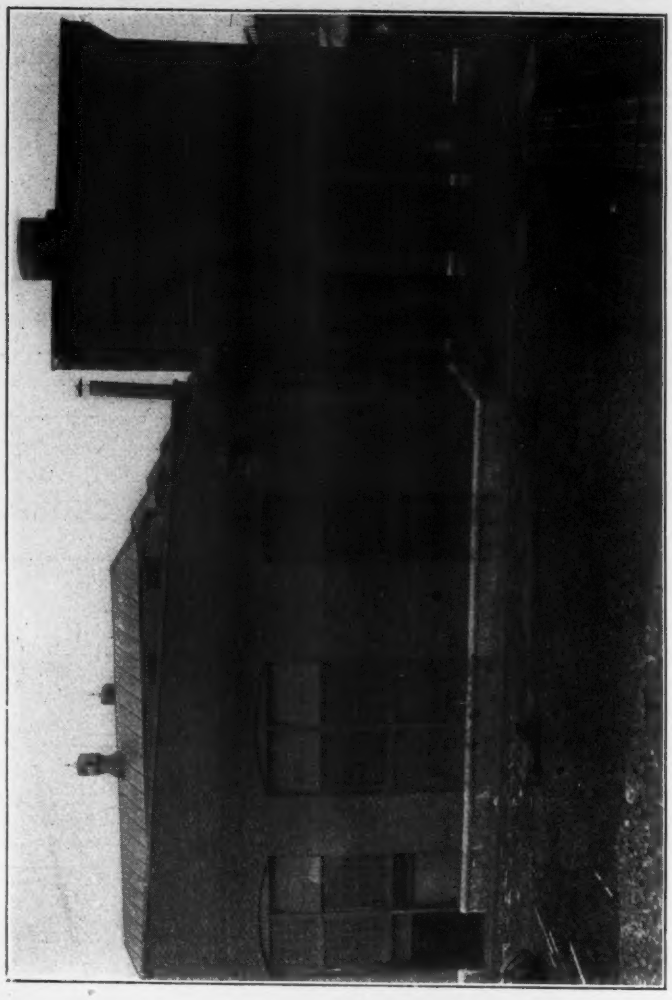


FIG. 5.—PARTIAL VIEW OF THE END OF THE WHEEL FOUNDRY AND THE ENTRANCE TO THE CHARGING ROOM ELEVATORS, LOOKING FROM THE TOP OF THE SCALE AND BREAKER HOUSE.

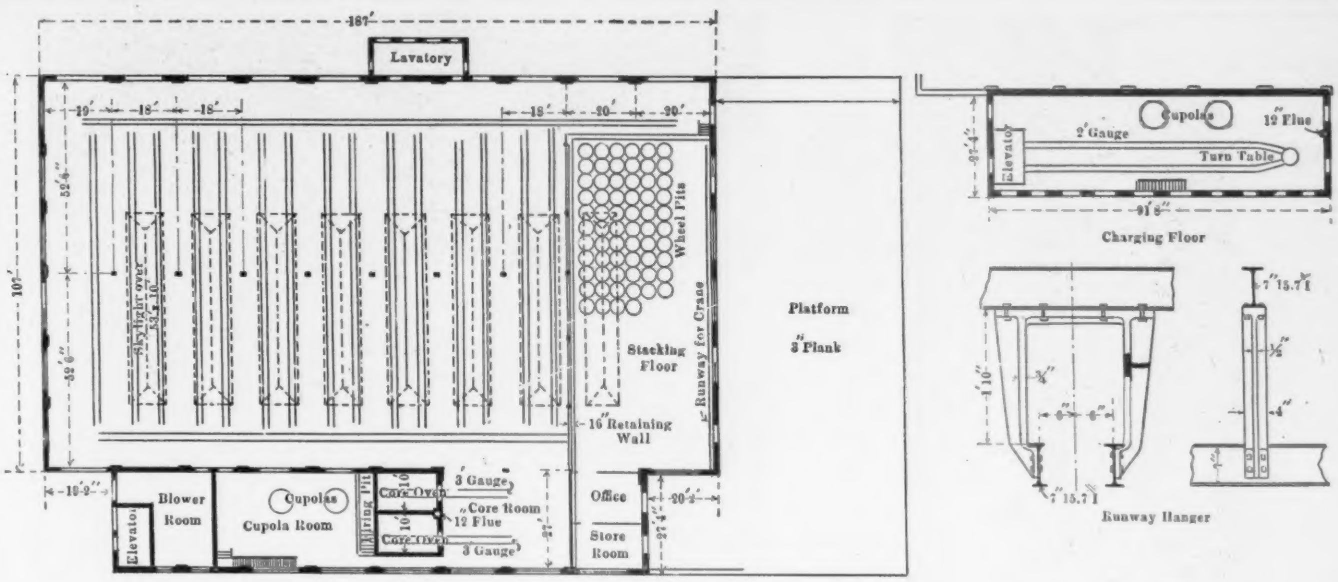


FIG. 6.—FLOOR PLAN OF WHEEL FOUNDRY.

lorry cars, one of which is clearly shown, and pushed into the breaker house, where it is weighed. The scrap wheels are rolled into the other side of the breaker house and broken. A portion of the scale room and the outside of the wheel breaking device are shown in Fig. 3. The breaker weight is hoisted by means of an air cylinder.

Reference to the general plan will show that there are three lorry tracks extending from the scale house to the charging room, the two outside ones being used for the loaded cars and the middle one for returning empties. A front view of the breaker house, with some of the lorry trucks, is shown in Fig. 4. The malleable scrap is stored to the left, only the edge of the pile appearing in this view. The lorry cars have a capacity of two tons each and are lifted to the charging floor by a double elevator operated by a single electric motor, one elevator ascending as the other descends. A partial view of the end of the foundry, showing the entrance to the elevator and fan room, is shown in Fig. 5; also the narrow gauge track alongside the end of the building, which extends to the coke storage and is connected by turntables to the tracks leading to the elevator. Coke is loaded into boxes, without bottoms, on lorry cars. These boxes carry 1,300 lbs. and are easily unloaded in the charging room. The cupolas are charged by hand, four men being required to handle the material from the elevator to the cupola. The arrangement of the narrow gauge tracks leading from the elevator to the cupolas is shown on the plan of the charging floor in Fig. 6.

The entire foundry equipment was furnished by the Whiting Foundry Equipment Company of Harvey, Ill. Two cupolas are provided and are used on alternate days, one being cleaned while the other is in use. These cupolas have 90 in. shells and are lined down to 72 in. at the widest part and 66 in. at the melting zone. They have a capacity of 110 tons or 18½ tons per hour. Between 13 and 14 ounces of blast are used.

The general arrangement of the foundry is shown on the plan, Fig. 6. The molding floor is divided into 15 rows of 21 molds each (daily output 315 wheels), the last mold being between the side wall and the track leading to the annealing pits. Solid cast iron chills are used. Each row is in charge of a molder assisted by a helper; the molding is completed by 10.30 or 11 A. M. when pouring is started. The cupola ladle discharges into five small ladles carried on five trucks, forming a train, and spaced the same distance apart, centre to centre, as are the molding floors. The train is operated by a motor-driven puller machine, controlled by the boy who operates the cupola ladle. Each row, or molding floor, is served by a 1,500-lb. crane. Two cables which control the crane extend across the foundry above the molds. By pulling one cable the crane may be moved to the right or left and by pulling the other the hoist may be raised or lowered, depending on the direction in which the controlling cable is pulled.

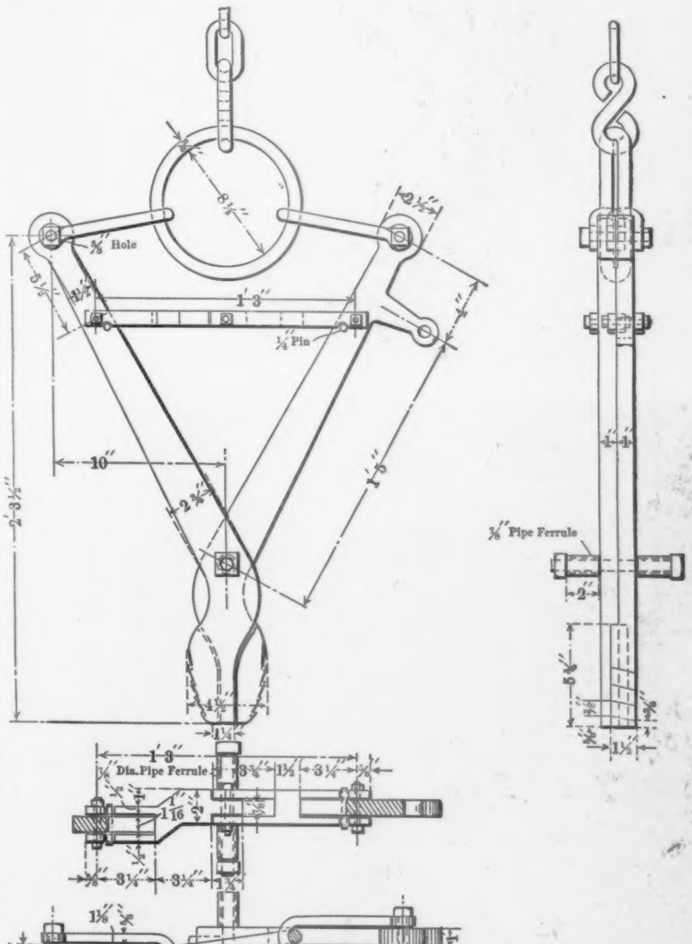


FIG. 9.—WHEEL TONGS USED AT ANNEALING PITS.

Six wheels are poured at one end of the first five rows. The same is done with the next five and then with the last five rows, the men in the rows first poured meanwhile taking out the wheels and sending them to the annealing pits. The wheels are carried to these pits on a train of four trucks which operates on the track on the opposite side of the foundry from the cupola. Nineteen minutes from the time the wheels are poured they are in the annealing pits. In hoisting the wheels from the truck to the annealing pits the tongs shown in Fig. 9 are used. These are quite simple and efficient and were designed by Mr. H. Nicholl,

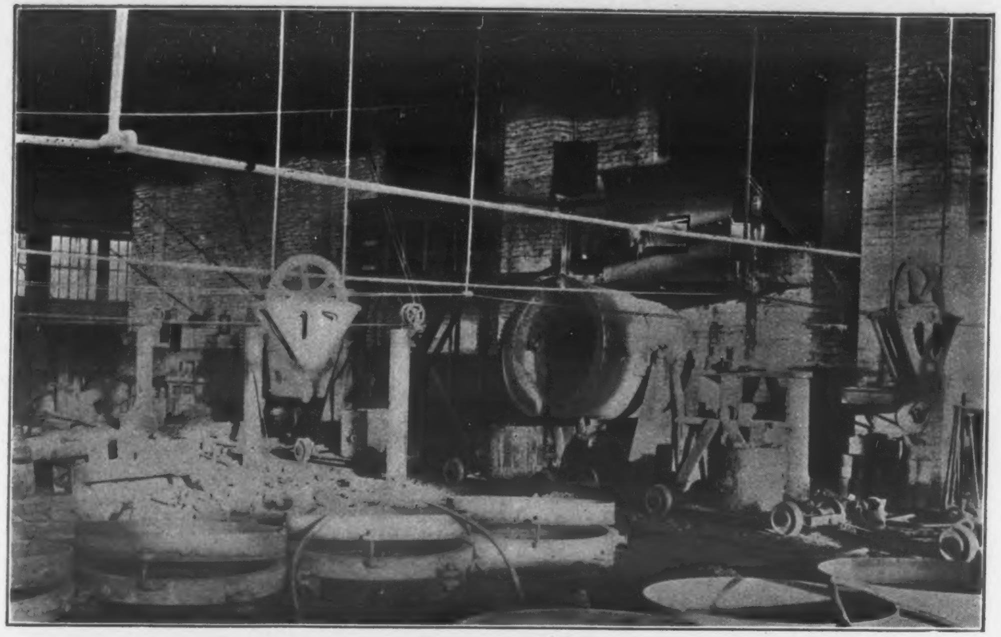


FIG. 7.—LOOKING TOWARD THE CUPOLA ROOM IN THE WHEEL FOUNDRY AND SHOWING SMALL LADLES ON TRUCKS.

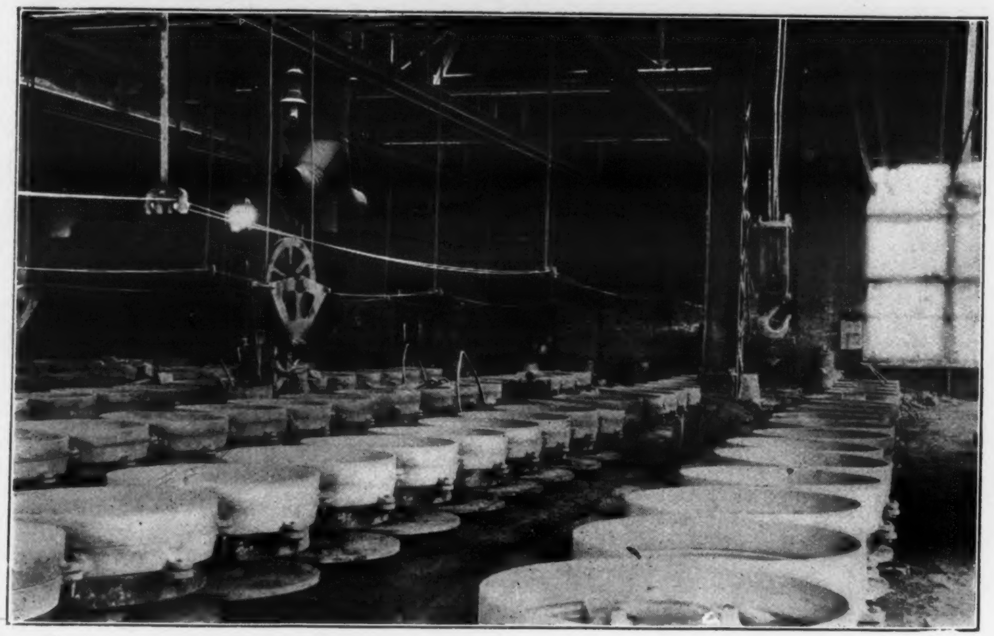


FIG. 8.—ARRANGEMENT OF MOULDING FLOORS IN THE WHEEL FOUNDRY, SHOWING THE CABLES WHICH CONTROL THE TRAVELING HOISTS ABOVE EACH FLOOR.

FIG. 10.—WHEEL FOUNDRY AND SHIPPING PLATFORM, LOOKING FROM THE TRUCK SHOP.

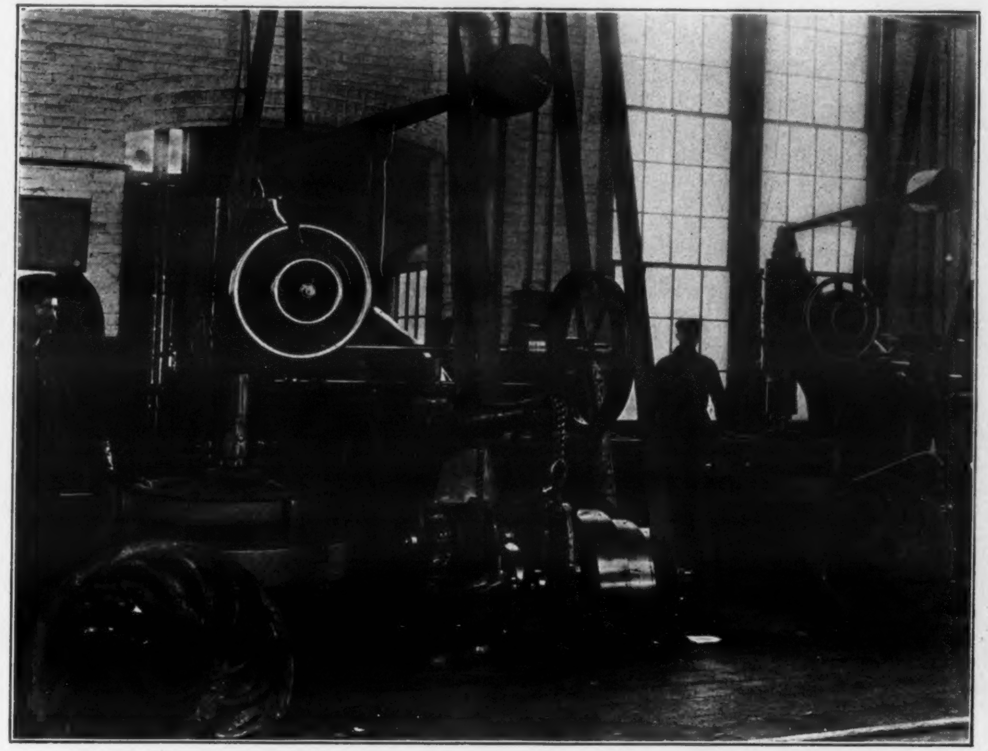
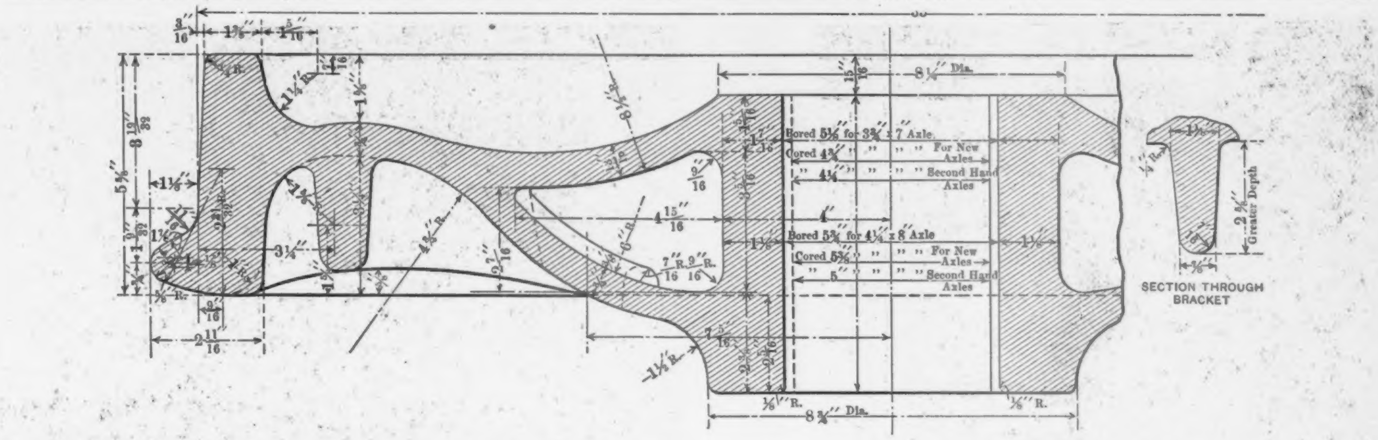


FIG. 13.—NILES WHEEL BORING MILL. THE WHEEL IN THE FOREGROUND LEANING AGAINST A WOODEN POST WILL FOLLOW THE ONE ON THE MACHINE.



the foreman. When the tongs are lowered into the hubs the centre of the hinged cross piece is forced upward and the tongs grip the wheel securely. When it is desired to remove the wheels from the pits the tongs are lowered, and when the end is in the hub the cross piece is forced upward by a chain. As soon as the wheel is lowered to the ground the arms tend to spread apart at the top, due to gravity, and the cross piece falls into place and prevents the tongs from gripping the wheel again.

A 3,000-lb. Whiting crane, with two hoists, thus handling two wheels at a time, extends over the annealing pits. As shown on the plan view, there are four rows of 11 pits and two of 10 each. Each pit holds 19 or 20 wheels. The wheels remain in the pits four days and are then placed on the floor, where they are stacked with a Whiting piling truck. After they have cooled sufficiently they are cleaned and taped. The finished wheels are then either rolled out on the platform, shown in Fig. 10, and loaded directly from this on a car for shipment to other points, or they are rolled to the truck shop to be bored and mounted, or are stored just outside of that shop.

A thermal test is made each day. Barber rollers for the freight car trucks are made of the wheel mixture and are cast in cast-iron molds. The core room and core ovens are located between the office and cupola room.

Design of the Cast Iron Freight Car Wheel.

Reference to the detail drawing of the Canadian Pacific standard 33-in. cast-iron wheel, Figs. 11 and 20, will show that it varies somewhat from M. C. B. recommended practice. The ribs are arranged with a much greater degree of curvature, thus making the wheel of greater elasticity and reducing trouble due to shrinkage. The flange is also considerably strengthened through the throat because of the additional metal at that point, due to the method of connecting the ribs to it. A somewhat larger core is used in the body of the wheel, the side walls being thinner than those of the M. C. B. wheel. They weigh 650 lbs., or the same as the M. C. B. wheel for 80,000 lb. capacity cars.

Wheel Shop.*

One is impressed with the devices, some of them very simple and yet effective, which have been provided to facilitate the handling of material and the operation of the machine tools, and to conserve the strength of the workman. The workman must not over-exert himself and become exhausted or the output is sure to suffer, and often it is the combination of a number of little things, each apparently unimportant in itself, which uses up his strength and reduces his efficiency and output.

Reference to the plan of that part of the wheel and truck shop, which is devoted to wheels and axles, will show that there is considerable storage room for wheels in the shop itself. The wheels are usually rolled in directly from the foundry; six boring mills are provided. A wooden post is placed near each mill, so that a wheel can be leaned up against it (Fig. 13), while waiting to be placed upon the machine, and can be quickly hoisted into place as soon as the other wheel is removed. The Niles 42-in.

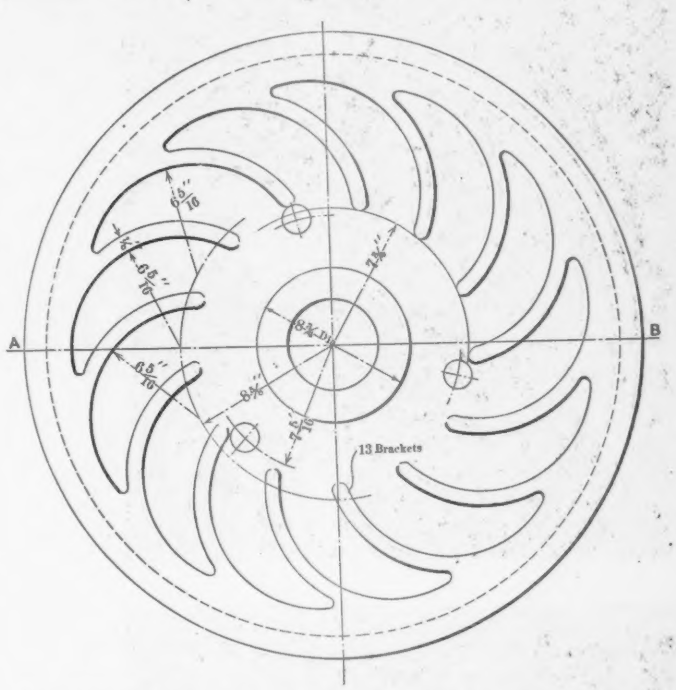


FIG. 11.—STANDARD CAST IRON FREIGHT CAR WHEEL—CANADIAN PACIFIC RAILWAY.

car wheel borer, shown in Fig. 13, has a record for boring 120 car wheels in ten hours. That these machines are operated at a fairly good rate is indicated by the fact that the men warm their tea and coffee, which they usually carry in bottles, in the borings. After the wheels have been bored they are rolled and temporarily stored in the middle of the shop near the wheel presses.

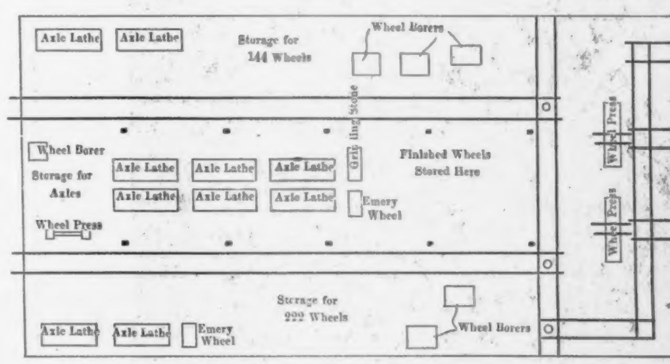


FIG. 12.—PLAN OF TRUCK SHOP.

The axles are stored just outside of the shop and are brought in by the cart, shown in Fig. 14, and also in a different position, in Fig. 15, which shows a group of Niles No. 3 double-axle lathes. One of these lathes has a record of turning twenty-six, $4\frac{1}{4}$ x 8 in., axles in ten hours. They are served by individual post cranes and the axles are picked up by the device shown hanging

*For a description of the construction of the building and additional details concerning the equipment, see pages 4 of the January and 114 of the April, 1905, issues.

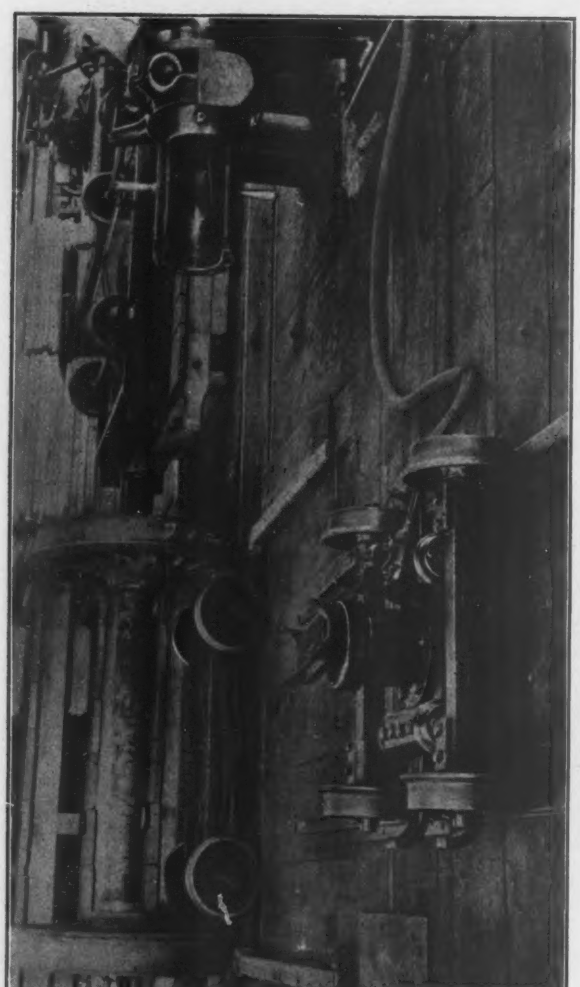


FIG. 19.—DOUBLE TRUCK FOR MOUNTING WHEELS AND AXLES, IN FOREGROUND. TRUCK FOR TRANSPORTING MOUNTED WHEELS AND AXLES ACROSS THE SHOP, IN THE REAR. IMPROVED SLEEVE ON THE PRESS AT THE RIGHT.

FIG. 20.—DEVICE FOR TURNING MOUNTED WHEELS OR LORRY TRUCKS—USED IN PLACE OF A TURNTABLE.

FIG. 14.—TRUCK FOR HANDLING AXLES.

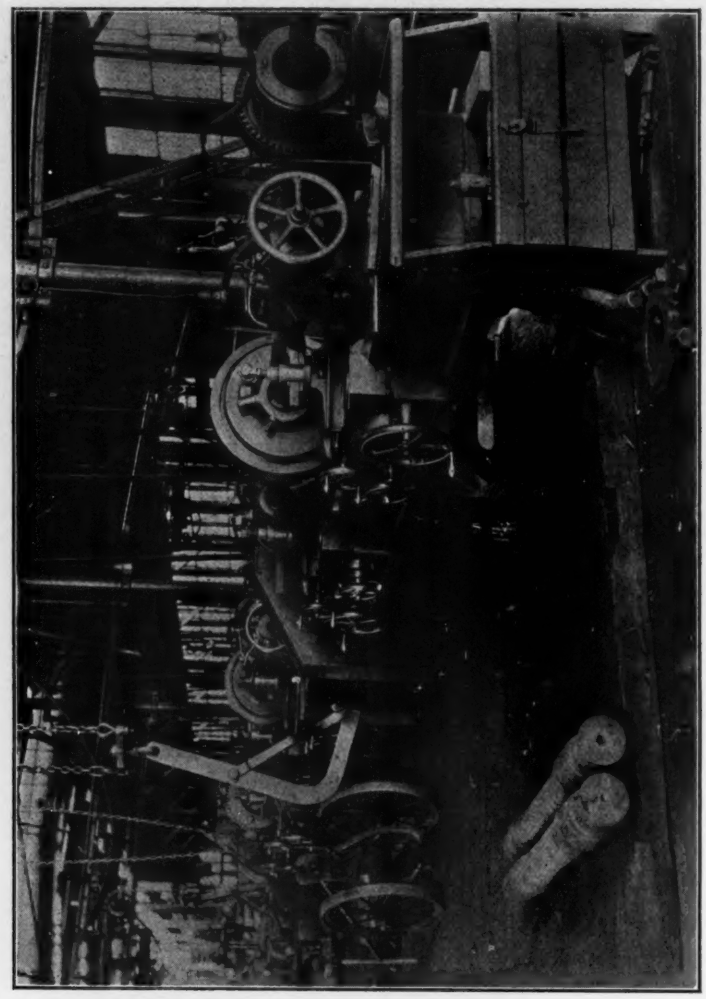


FIG. 15.—A GROUP OF AXLE LATHES WITH AXLE HANDLING TRUCK AT THE LEFT.

FIG. 17.—AIR HOIST IN WHEEL SHOP.

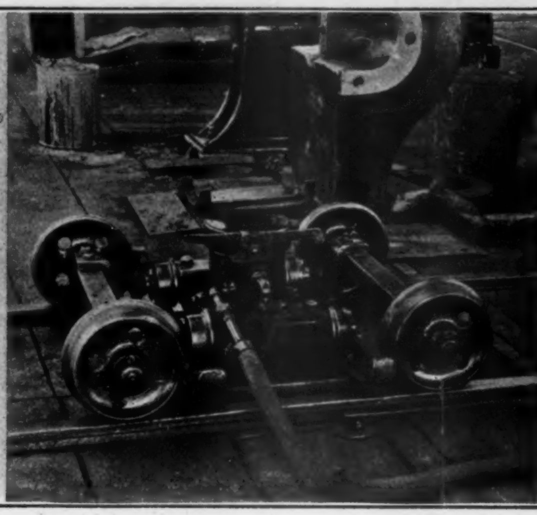


FIG. 18.—DOUBLE TRUCK AT THE WHEEL PRESS.

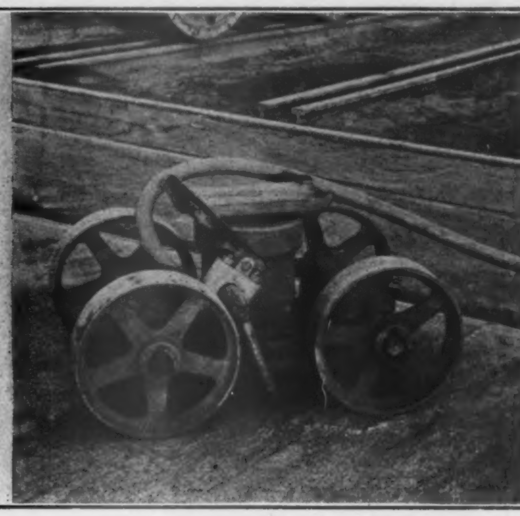


FIG. 21.—PORTABLE PNEUMATIC DEVICE FOR TURNING MOUNTED WHEELS.

from the crane in Fig. 15. To facilitate the picking up of axles with this device they are not laid flat on the floor, but are supported at one end by the plank shown in the foreground. The lathes rest upon concrete foundations (Fig. 16), each foundation being large enough to take two lathes, placed back to back. The cuttings and lubricating compound drop into a pit 14 in. deep, and the compound is drained into a cavity at the centre which contains a sheet iron tank. From this it is pumped back into circulation. The cuttings are cleaned out at regular intervals by laborers, and do not interfere at all with the operator.

These lathes are operated at high speed and to save time, when it is necessary to stop them, a brake, which is operated by the foot, has been placed on the large driving pulley, and quickly brings the machine to a stop. It is important to use cutting tools of a standard size in order that the workman may have as little difficulty as possible in changing from one to another. The shank of the burnishing tool has a pin passing through it which backs up against the tool post, and the only function the set-screw has to perform is to steady the tool. The operator does not have to screw it down nearly as tightly as when it is depended upon to keep the tool from slipping backward.

After the axles have been turned they are stored temporarily near the wheel presses. When ready to have wheels mounted upon them they are picked up by an air hoist, shown in Fig. 17, which operates on the overhead track, and are deposited upon the small truck shown in Figs. 18 and 19. It will be seen that the air hoist has a reservoir attached above it. This is to provide for the traveling back and forth of the hoist and to do away with having an extremely long hose. The reservoir is charged by running it under the charging device, shown in the illustration, it being only necessary to pull the chain, which is shown suspended, thus making an air-tight connection between the reservoir and the charging device and at the same time allowing air to flow into the reservoir. The reservoir has a capacity sufficient for the handling of 3 or 4 axles without re-charging.

The truck upon which the axle is placed preparatory to mounting, Figs. 18 and 19, consists practically of a double truck, the lower portion having a forward and backward movement, and the upper a sidewise motion. As soon as the axle has been placed upon it and the wheel seat has been white leaded, one of the wheels is rolled alongside the truck and the end of the axle is slipped into it by moving the upper part of the axle truck sidewise. The second wheel is then brought forward, and by pressing the lever lightly with the foot air is admitted to the cylinder and the plunger is forced upward raising the end of the axle sufficiently so that the wheel may be slipped over the end. The plunger is then raised to its full height and the truck is moved forward under the wheel press. The wheel press is fitted with a recording pressure gauge as well as with an ordinary gauge. The pressures required for applying wheels for cars and tenders are as follows:

PRESSURES FOR APPLYING WHEELS TO AXLES.

Size of Journals.	Standard Diameter of Wheel Fit.	Cast Iron Wheels.	Steel Tired Wheels.
3¾ x 7	5⅛	30 to 40 tons	45 to 55 tons
4¼ x 8	5¾	35 to 45 "	50 to 60 "
5 x 9	6½	40 to 50 "	60 to 70 "
5½ x 10	7	45 to 55 "	65 to 75 "

An interesting improvement has been made to the wheel press, which adds greatly to its usefulness. Instead of having the sleeve hung from the cross bar it has been fastened on the end of the ram and can be rotated by means of the two handles. While the wheels are being pressed on it is held securely in position by a set screw, but afterward when it is necessary to swing the mounted wheels around in order to place them on the track in the rear of the press, the set screw is loosened and the sleeve revolved 180 degrees, allowing the axle to swing back.

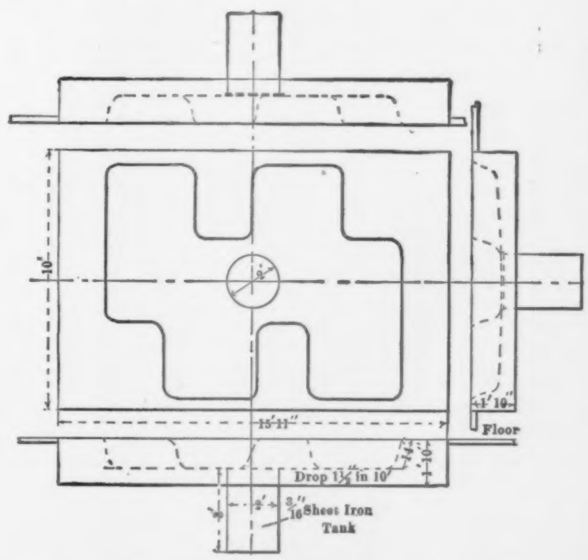


FIG. 16.—CONCRETE FOUNDATIONS FOR AXLE LATHES.

Another characteristic improvement is that the block, which is placed between the end of the axle and the ram, is hung from a hook instead of being left to lie on the floor, and is therefore always at hand when required. The mounted wheels after they have been swung back of the press are run on the wheel truck, shown in Fig. 19, and are moved to one of the tracks running lengthwise through the shop, depending upon whether they are to be used at once in the truck shop or are to be shipped or stored outside of the shop.

Another interesting device, which is not only used extensively in the shops in place of turntables, but is also used in a modified form throughout the yards where it is not advisable to use turntables because heavy cars and locomotives must operate over the

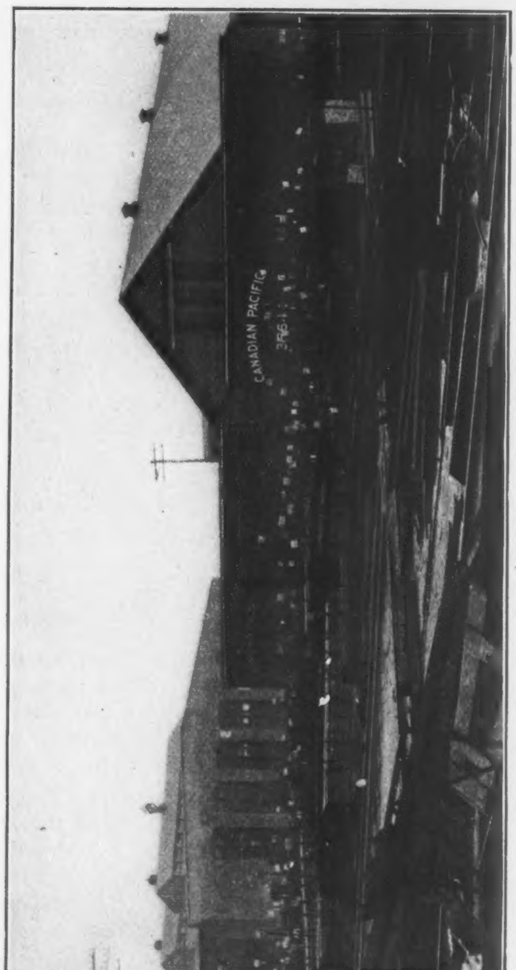


FIG. 23.—MATERIAL FOR BLACKSMITH SHOP USE.

FIG. 24.—AJAX BRAKE LEVER ROLLS.

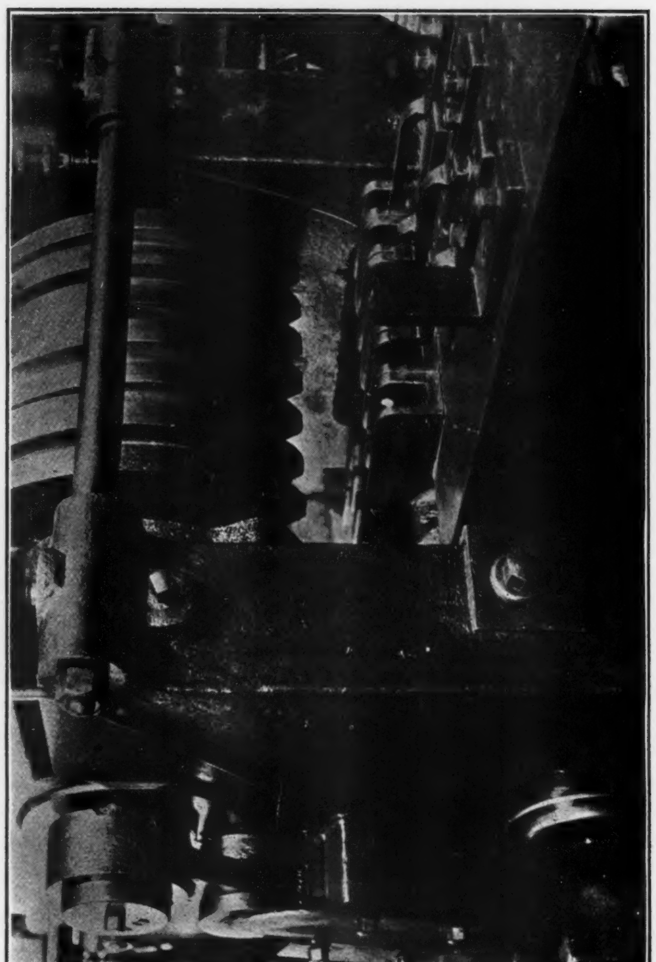


FIG. 25.—REAR VIEW OF AJAX BRAKE LEVER ROLLS. SHEAR FOR ROUNDING ENDS AT LEFT SIDE.

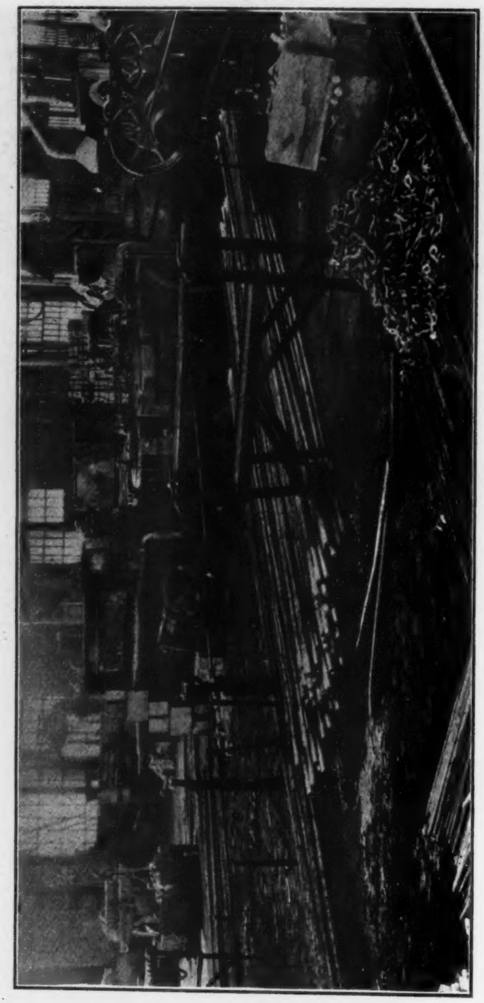
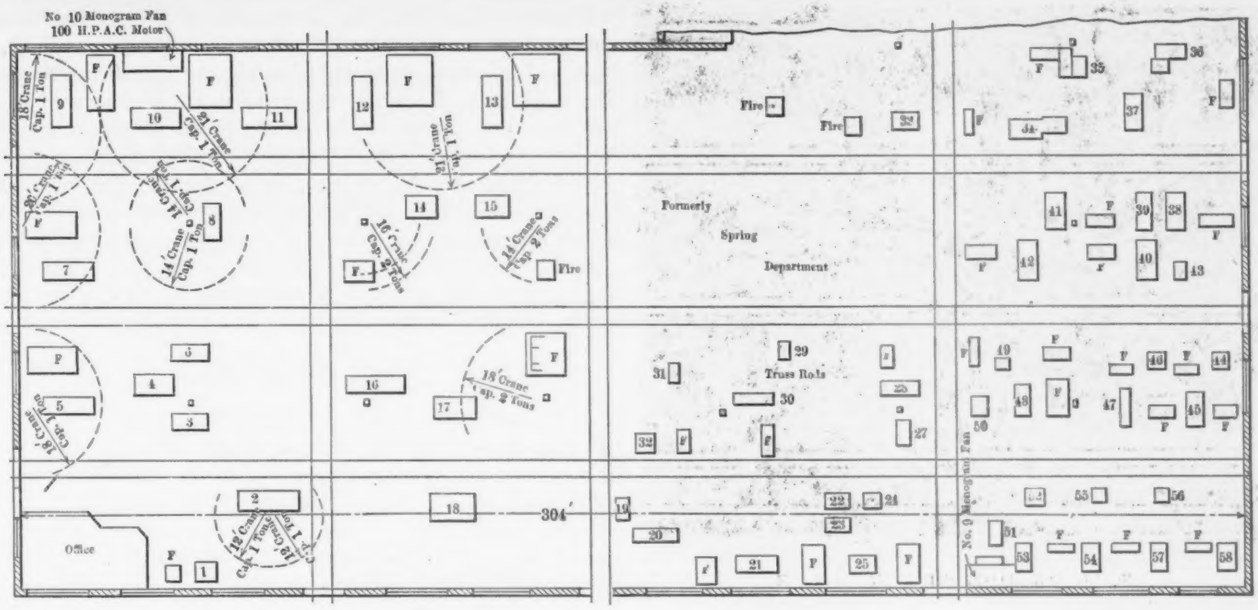


FIG. 26.—PART OF THE TRUSS ROD DEPARTMENT IN THE SMITH SHOP.



F.—FURNACES
1. Ajax Bending Rolls
2. Punch and Shears
3. Punch and Shears
4. Bulldozer, Cold
5. Bulldozer
6. Punch and Shears
7. Bulldozer
8. Punch and Shears
9. Bulldozer
10. Bulldozer
11. Bulldozer
12. Bulldozer
13. Bulldozer
14. 2,000-lb. Hammer
15. 1,200-lb. Hammer
16. Punch and Shears
17. 2,000-lb. Hammer
18. 600-lb. Hammer
19. Scale
20. 3-in. Forging Machine
21. 1½-in. Nut Machine
22. 1½-in. Nut Machine
23. 1½-in. Nut Machine
24. Scale
25. ⅝-in. Nut Machine
27. Single Shears
28. 2-in. Upsetting Machine
29. 2-in. Bolt Cutter
30. 2-in. Upsetting Machine
31. 2-in. Bolt Cutter
32. Pneumatic Riveter
33. Flat Iron Saw
34. No. 9 Monogram Fan
35. 200-lb. Beaudry Hammer
36. 350-lb. Beaudry Hammer
37. Punch and Shears
38. 100-lb. Bradley Hammer
39. 100-lb. Bradley Hammer
40. 100-lb. Bradley Hammer
41. 100-lb. Bradley Hammer
42. 200-lb. Bradley Hammer
43. Light Pneumatic Bulldozer
44. Eye Bolt Machine
45. 1½-in. Bolt Header
46. Eye Bolt Machine
47. 2-in. Forging Machine
48. 1½-in. Rivet Machine
49. Forging Machine
50. Bolt Header
51. Bolt Header
52. Round Iron Shears
53. 1½-in. Bolt Header
54. 1½-in. Bolt Header
55. Round Iron Shears
56. Round Iron Shears
57. 1½-in. Bolt Header
58. 2-in. Bolt Header

FIG. 22.—PLAN OF THE BLACKSMITH SHOP FOR THE CAR DEPARTMENT.

track, is shown in Fig. 20. By pressing one of the pins air is admitted to the air cylinder and the piston is forced upward, allowing the wheels or lorry truck to be swung around; by pressing the other pin the air is released.

Another device, quite similar to the one above described, is shown in Fig. 21. It is often necessary to store mounted wheels on tracks at right angles to the one on which they are brought out of the shop, and it would hardly be advisable to install a lot of turntables for turning them; it is an awkward job to do it by hand and requires two men. The truck shown can easily be moved to any point in the yard and the air hose run to the nearest connection. It is only necessary to roll the wheels over the truck, press the lever down with the foot to admit air to the cylinder, and swing the wheels around, release the air, and run them off on to the side track.

Gray Iron Foundry.

All of the gray iron castings for the locomotive and car departments are made in the foundry, which lies alongside of the locomotive shop, with one end facing the midway. As a number of improvements are at present being made in the equipment and operation of this foundry it will not be considered at length, but will be taken up in detail in connection with a study of the passenger car department, which we expect to present later. The castings are delivered from the foundry to the storage bins at the truck shop and freight car shop on lorry cars, over the tracks shown on the general plan. Castings for shipment to outside points are transferred to the storehouse.

The Smith Shop.*

The wing of the blacksmith shop, directly opposite the car machine shop, is devoted entirely to work for the car department. It is about 130 ft. wide by 304 ft. in length. The output of this part of the shop averages 180 tons per day and eight trucks, four men to a truck, are required for handling the material to the machines and delivering it to the shops where it is to be finished or applied. There are numerous doors in the building and the raw material is stored just outside the shop and as near the machine, where it is to be forged, as possible.

It is the practice to order the iron and steel cut to length for the various purposes for which it is to be used. This simplifies the problem of storing it to advantage and cuts out considerable rehandling of material, greatly facilitating the progress of the work through the shop. About 5,000 lbs. of wrought iron or mild steel are used in each 30-ton standard box car and at the rate of 28 or 30 cars per day, the work of the smith shop must be carefully planned to cut out lost motion in order to keep up the output for these cars, in addition to that for the passenger car department and for shipment to outside points.

Along the northern side of this building is a shed (indistinctly shown in the background at the left in Fig. 38), under which a large amount of material is stored for use in machines along that side of the shop. One is surprised at the extremely heavy construction of this shed, but when the heavy snowfall is considered, as well as the fact that the greater portion of the snow upon one side of the shop roof may be precipitated upon it, it is not to be wondered at. The more expensive material, including the tool steel, is stored in a 76 x 64 ft. frame building, east of the shop. A large amount of bar iron and rods are stored between the end of the shop and the reservoir, and just south of the reservoir. This storage yard is partially shown in Fig. 23. The wooden tablets showing the sizes of the iron are supported at the ends of rods and are at least four or five feet above the ground, thus making it possible to locate the material after a heavy snowfall.

A plan view of the car blacksmith shop is shown in Fig. 22. Coming into the shop, at the end nearest the power house, one is first attracted by the Ajax brake lever rolls, which are shown in Figs. 24 and 25. The dies are made adjustable, so that by unscrewing three screws and screwing up three on the opposite side the eccentric on the upper roll is changed. The same can also be done on the lower roll, which gauges the length of the taper to be rolled. The thickness of the lever may be changed as much as ⅜ in. by raising the upper roll. The machine is fitted with a shear, at the side, for rounding the ends of the levers. From 500 to 750 levers can be made in a day of ten hours.

* For details of the construction of the smith shop see pages 5 of the January, and 37 of the February, 1905, issues. The arrangement and equipment, at the time it was first put in service, are described on page 363 of the October, 1905, issue.

FIG. 27.—BOLT FORGING MACHINE, SHOWING THE CHUTE WHICH CONDUCTS THE FINISHED BOLTS TO A STEEL BOX SET IN THE FLOOR.

This end of the shop is fitted with several punches, shears and bulldozers. The bulldozer for forging arch bars has a centering attachment which adjusts the bar so that after being pressed both ends are symmetrical, regardless of any slight variation there may be in the length of the bars. One of the dies has a shallow blade which makes a mark at the centre of the bar, and this is used to facilitate the setting up of the bars when they are placed on the drilling machines in the machine shop. The six spindles of the drilling machine are set to template and the arch bar is quickly adjusted according to the mark at its centre.

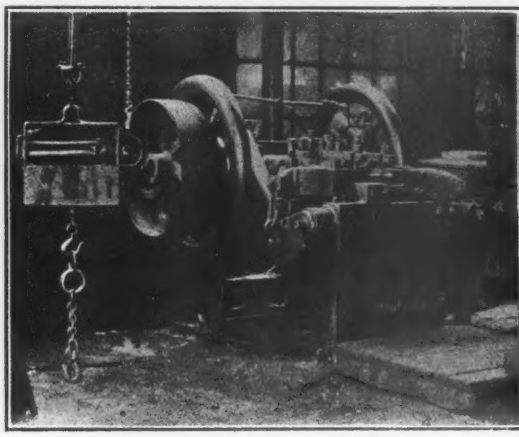


FIG. 28.—FORGING MACHINE AND SCALE ON THE HOIST FOR WEIGHING BOLTS.

FIG. 29.—STEEL BOXES FILLED WITH BOLTS AND READY TO BE TRANSFERRED TO THE MACHINE SHOP.

With the large number of truss rods which it is necessary to provide, considerable attention can be given to manufacturing them efficiently. A study of the plan will indicate that arrangements have been made to up-set both ends of the bar and thread them without turning the bar end to end. Two sets of furnaces, up-setting machines and bolt cutters, have been provided, as shown both on the plan (Fig. 22) and in Fig. 26.

The spring department is being removed to the new wing of the building and this space can now be used entirely for car department work.

One small department is given over to the manufacture of nuts and contains two nut machines, two burring machines and scales upon which the nuts are weighed, the piece workers' wages being based on these weights. The nuts are placed in boxes, before being weighed, and these are piled upon trucks and pushed through into the car machine shop, where the nuts are tapped. A similar feature is noticeable in connection with the manufacture of bolts. The bolts are dropped from the forging machine into steel buckets, shown in Fig. 27. These are hoisted by a crane and loaded on trucks and transported to the car machine shop, where the bolts are threaded. A scale is hung on a hoist (Fig. 28), and the bolts are weighed while they are being lifted from the machine to the truck, the piece workers' wages being based on these weights. A number of the boxes of bolts are shown in Fig. 29, as well as one of the Ajax forging machines. The bolt boxes are made of boiler plate. From the time the bolts and nuts are made until they are placed in the storage bins they do not touch the ground, but after each operation are dropped directly into the boxes or buckets. This reduces the cost of handling to a minimum. Fig. 30 shows a Williams & White eye-bolt machine, which is used for bending the ends of the brake hangers.

Car Machine Shop.*

Only that part of the car machine shop will be considered which is devoted to work used on freight cars, or that part which lies nearest the midway. The office of the superintendent of the car department is located upstairs at the northeast corner, and directly underneath it, and extending a considerable distance down the shop are the brass repair, cleaning and lacquer rooms. It is quite probable that this department will be removed to the new passenger shops when they are completed. The most noticeable features in connection with the operation of the car machine shop are the provisions for the comfort of the men and the facilities for turning out the work expeditiously. An idea of the out-

* For a description of the building see page 4 of the January, 1905, issue. The equipment and its arrangement are considered on page 114 of the April, 1905, issue.

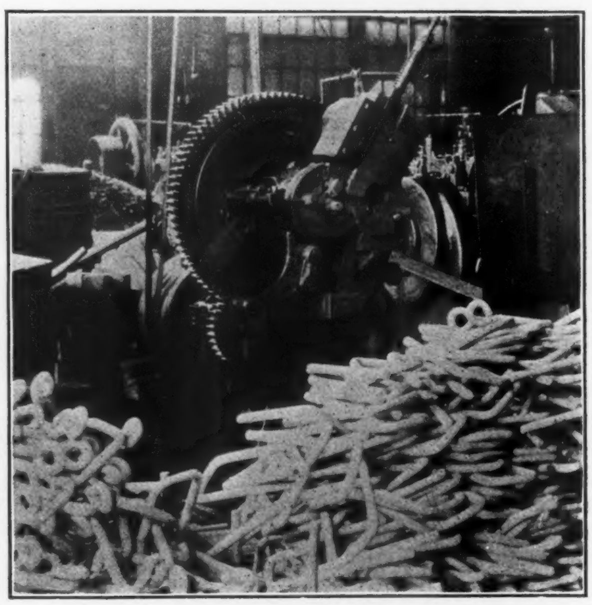


FIG. 30.—EYE-BOLT MACHINE FOR BENDING THE ENDS OF THE BRAKE HANGERS.

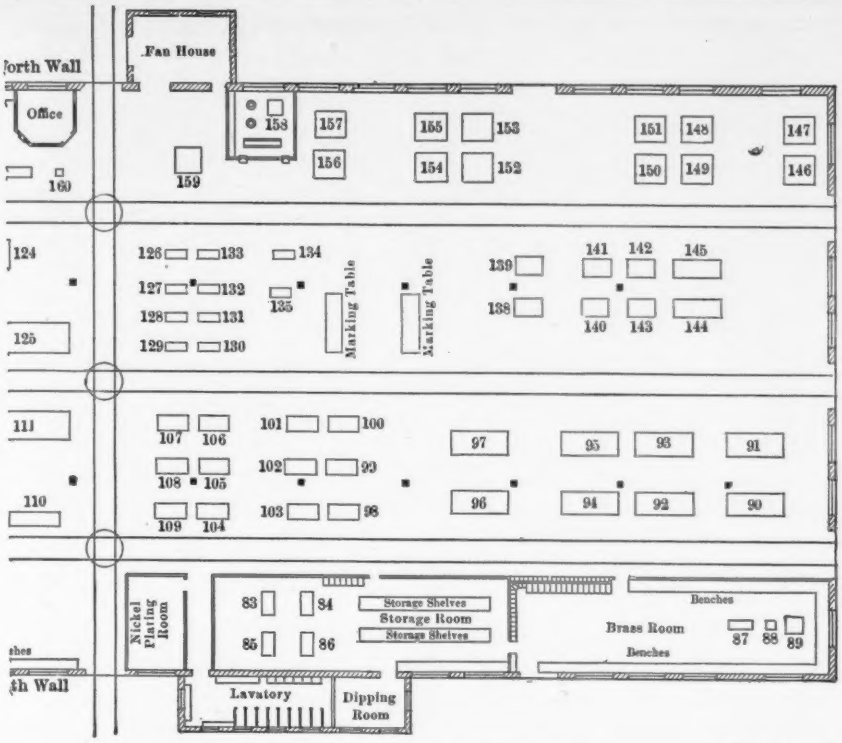


FIG. 31.—PARTIAL PLAN OF THE CAR MACHINE SHOP.

CAR MACHINE SHOP.

No.	Name and Maker.	Motor H. P.
83.	Double buffer	
84.	Double buffer	10
85.	Double buffer	
86.	Double buffer	
87.	¾-in. turret lathe, Bertram & Sons	5
88.	16 in. sliding head drill press, Hamilton Machine Tool Company.	
89.	Miller, Smith & Coventry	
90.	6-spindle arch bar drill, Niles Tool Works	
91.	6-spindle arch bar drill, Bertram & Sons	
92.	6-spindle drill	
93.	6-spindle arch bar drill, Bertram & Sons	30
94.	6-spindle drill, Bertram & Sons	
95.	6-spindle drill, Bertram & Sons	
96.	6-spindle drill, Bertram & Sons	
97.	6-spindle drill, Bertram & Sons	
98.	32-in. vertical drill, Bertram & Sons	
99.	28-in. vertical drill, Cincinnati Machine Tool Company	
100.	25-in. vertical drill, Bertram & Sons	
101.	28-in. vertical drill, Cincinnati Machine Tool Company	
102.	28-in. vertical drill, Cincinnati Machine Tool Company	
103.	28-in. vertical drill, McGregor & Gourley	
104.	26-in. vertical drill, Prentice Bros.	15
105.	20-in. vertical drill, Prentiss	
106.	20-in. vertical drill	
107.	30.in. vertical drill	
108.	26-in. vertical drill, Bertram & Sons	
109.	25-in. vertical drill, Bertram & Sons	
126.	6-in. small vertical drill, C. P. R.	
127.	6-in. small vertical drill, C. P. R.	
128.	6-in. small vertical drill, C. P. R.	
129.	6-in. small vertical drill, C. P. R.	
130.	6-in. small vertical drill, C. P. R.	5
131.	6-in. small vertical drill, C. P. R.	
132.	6-in. small vertical drill, C. P. R.	
133.	8-in. small vertical drill, W. F. & T. Barnes Company	
134.	16-in. sliding head drill press, Hamilton Machine Tool Company.	
135.	16-in. sliding head drill press, Hamilton Machine Tool Company.	
138.	2-in. 6-spindle nut tapper, Acme Machine Company	
139.	2-in. 6-spindle nut tapper, Acme Machine Company	
140.	1½-in. 6-spindle nut tapper, Acme Machine Company	
141.	1-in. 6-spindle nut tapper, Acme Machine Company	
142.	1½-in. 4-spindle nut tapper	10
143.	1-in. 4-spindle nut tapper	
144.	1½-in. 6-spindle nut tapper	
145.	1½-in. 6-spindle nut tapper	
146.	1¾-in. double bolt threader	
147.	1½-in. double bolt threader	
148.	1½-in. double bolt threader, A. R. Williams Machine Company	10
149.	1½-in. double bolt threader	
150.	1½-in. triple bolt threader, Bertram & Sons	
151.	1½-in. triple bolt threader, Bertram & Sons	
152.	1½-in. double bolt threader, National Machine Company	
153.	2-in. triple bolt threader, National Machine Company	
154.	1-in. double bolt threader	
155.	1½-in. double bolt threader, National Machine Company	
156.	2-in. triple bolt threader, Bertram & Sons	10
157.	2-in. triple bolt threader, Bertram & Sons	
158.	Drill grinder, Washburn Shops	
159.	Universal milling machine, No. 3, Cincinnati Milling Machine Company	
160.	Universal tool grinder, Cincinnati Milling Machine Company	

put of this shop may be gained from the fact that the store orders amount to more than the requirements at the Angus shops.

Three things are necessary to get the maximum output from a machine; a good machine; a good operator and good surroundings, including facilities for handling the work and for the comfort and convenience of the operators. Apparently all three of these have been given special attention. The machine tools are kept in an excellent state of repair; the material is handled in a neat and orderly manner; special facilities are provided for handling the work to and from the machines and clamping it in place; the operator's comfort and convenience have been studied and provided for. These features may best be emphasized by reference to the accompanying photographs.

The plan of that part of the shop in which most of the freight car parts are finished is shown in Fig. 31. Entering the door from the midway attention is first directed to the group of six-spindle drills, two of which are used entirely for drilling arch bars. One of the arch bar drills is shown in Fig. 32. Provision has been made for conducting the lubricating compound to a well from which it is circulated by a pump. The plank fastened to the front of the machine prevents the compound from splashing on the feet of the operator. In addition to this, and to prevent the compound gathering where the operator will be forced to step into it, a platform has been constructed as shown. Such of the compound or cuttings as may fall in front of the machine drop through the grating out of the way. The machine is provided with special facilities for quickly clamping the bars in place, as shown. Fig. 33 shows an arrangement which is used in connection with the drilling of steel wheel centres for passenger car work. The lubricating compound is drawn off through the funnels and drains to a well underneath, the same kind of floor for keeping the operator's feet dry being provided, as described above. A crane swings over this machine for hoisting the centres into place and they are held in a jig and drilled to template.

Provision for keeping the operators' feet dry and keeping the cuttings from under their feet has been made not only for the large machines, but also for the smaller ones, as shown in Fig. 34. The arrangement of this machine is similar to that of the other small drill presses and sensitive drills. The drill illustrated is used for drilling the cotter pin holes in brake beams. The pins are delivered from the blacksmith shop in boxes, shown alongside the machine, and the operator fills an empty box with the finished pins as he empties one of the others. That the provision for the men's comfort is appreciated is shown by the fact that they are careful to keep these features in good condition and repair.

In many of the iron freight car parts the holes are punched in the smith shop, but when they must be made to take pins, as in the brake lever jaws, etc., it is necessary to drill or ream them; there are also places where it is impossible to punch the holes. Usually the drills are fitted with clamping devices for holding the pieces so that the piece may be released or fastened in place with the tap of a hammer or pulling a lever. A jig for drilling the dead lever guides is fitted with a spacing device, the guide being shifted the proper distance between the holes by pulling a lever, marking off being thus made unnecessary.

Fig. 35 shows a row of nut tappers. The nuts are brought in from the blacksmith shop in the boxes, and as they are tapped they are dropped into a slide which carries them to the buckets back of the machines. The capacity of these buckets is just equal to that of one of the boxes. The machine in the foreground has not been equipped in this way, it being necessary for the operator to drop the nuts in the buckets in front of the machine. The other machines are, however, equipped in the same way as the one shown to the right. The boxes are weighed by a storehouse representative, and those which are to be shipped to outside points have covers nailed on them and are sent to the storehouse. Here also are seen the special platforms for keeping the operators' feet dry, the compound being drained off into wells underneath the machines.

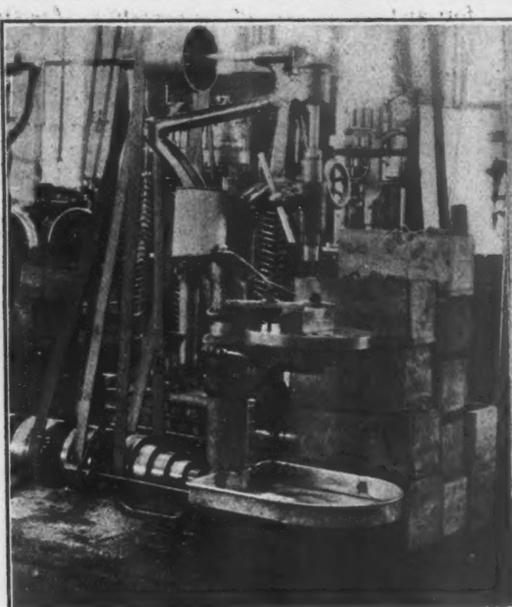


FIG. 34

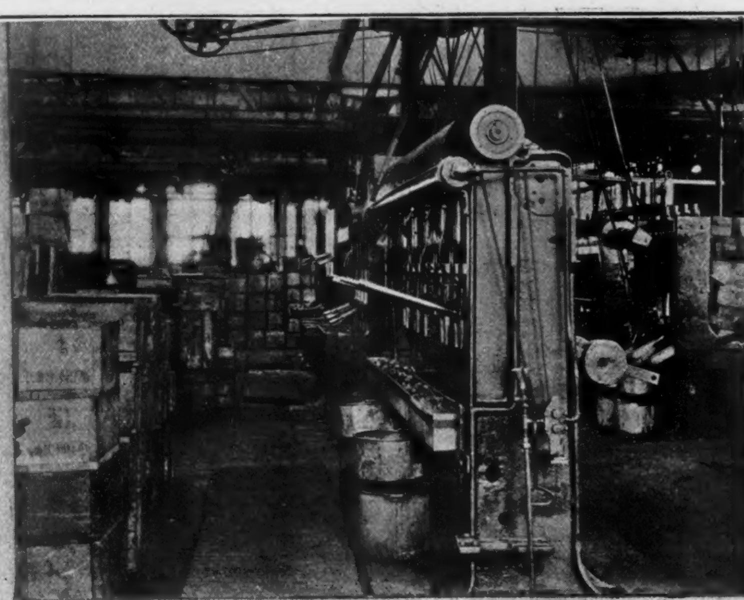


FIG 35

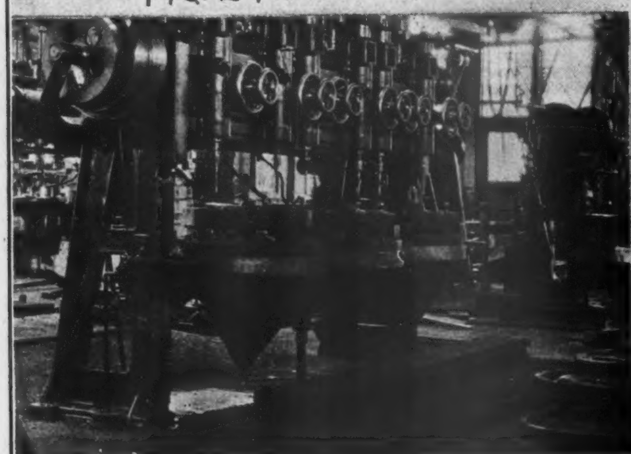


FIG. 33

FIG 36

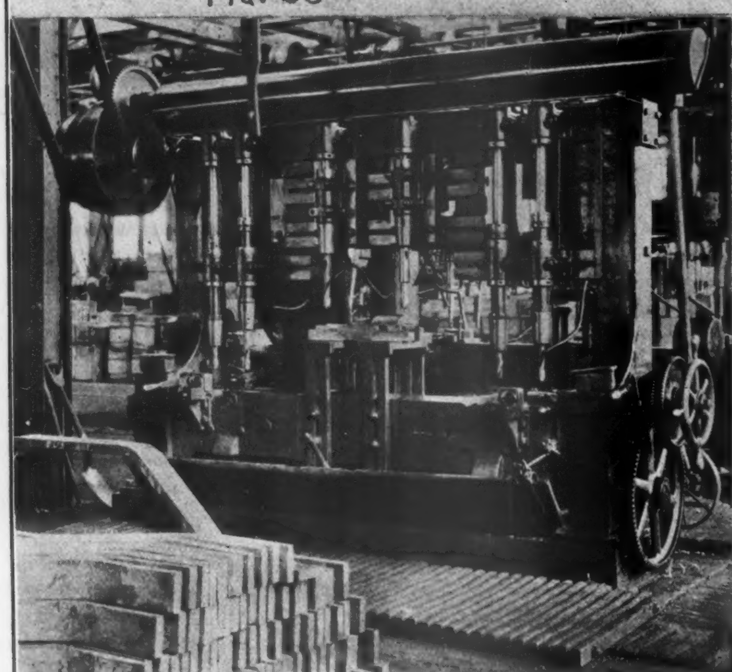


FIG 32

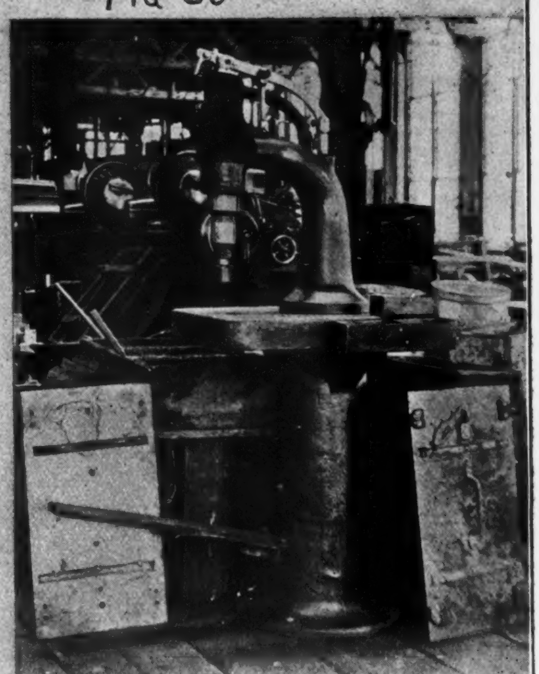


FIG. 37

FIG. 32.—SIX-SPINDLE ARCH BAR DRILL.

FIG. 33.—SIX-SPINDLE DRILL USED FOR STEEL PASSENGER CAR WHEEL CENTERS.

FIG. 34.—SENSITIVE DRILL USED FOR DRILLING COTTER PIN HOLES IN BRAKE PINS.

FIG. 35.—NUT TAPPING DEPARTMENT.

FIG. 36.—STEEL BOLT BOXES. BOLT THREADER IN THE REAR.

FIG. 37.—PNEUMATIC HAMMER FOR RIVETING FIXTURES TO STEEL END DOOR OF BOX CARS.

Along the north side of the shop are a number of bolt cutters. The bolts are brought in from the blacksmith shop in the iron boxes, shown in Figs. 27, 29 and 36, and are unloaded by a crane and placed convenient to the machine upon which they are to be threaded. As the bolts are threaded they are thrown into an empty box, and when this is filled it is placed with others on a truck and delivered to the storehouse or to the shop in which they are to be used. The rods for the framing of the box cars are also threaded in this department.

An interesting home-made device is used for riveting the different parts on the iron end doors of the standard box car. It consists of the body of an old long stroke air hammer attached to a frame, as shown in Fig. 37. Rivets are driven cold. As the treadle is pressed down the end of the hammer is brought down on the head of the rivet and is placed in operation.

Such material as is not brought directly into the car machine shop is stored outside at the most convenient point to the machine upon which it is to be finished. For instance, the rods which are used in the framing of the box cars, are stored along the north side of the machine shop, nearest to the bolt cutting machines. It is important in handling the large amount of this material to keep from getting the different size rods mixed and a very simple precaution has been taken to prevent this, as shown in Fig. 38. In addition to having the size plainly stencilled on the front of the bin the back of the bin is adjusted for the length of the rod which is to be placed in it, and as the rods are piled they are pushed back until they come in contact with the back. If the wrong length is put in a bin it immediately becomes noticeable. A clear passageway has been left between the back of the bin and the side of the building, and while this may seem a waste of space, yet it is possible to keep the surroundings much neater and cleaner than under other conditions.

FIG. 38.—STORAGE BINS FOR RODS OUTSIDE OF MACHINE SHOP. STORAGE SHED ALONGSIDE THE BLACKSMITH SHOP IN THE REAR.

FIG. 39.—ERECTING TRACK IN TRUCK SHOP.

FIG. 44.—GARRY PNEUMATIC CRANE FOR UNLOADING BOLSTERS, ETC.

Truck Shop.

One end of the wheel shop is used for finishing the wheels and axles and mounting them, as has been described. The remaining portion is devoted to the building and repairing of passenger car trucks and the building of freight car trucks. When the freight car shop is engaged in building box or refrigerator cars, only one track is used for building trucks, but when an order of flat cars is being built it is necessary to use two tracks. The truck gang, for an output of 28 standard 30-ton box cars per day, consists of seven men, including the foreman.

The mounted wheels are rolled on at one end of the track. The truck advances from one stage of construction to another, the material being piled at the proper place alongside the track, and each man having certain parts of the work which he must perform. The men are paid on a piece-work basis, and if one man slows up his associates see to it that he makes up for lost time, for the output of the entire gang will suffer. In like manner, if one man has difficulty in adjusting a part, the others see to it that he is given proper assistance. The gang works like a machine, except that intelligence is combined with energy, and if one part becomes clogged the energies of part of the gang are momentarily concentrated at that point until the difficulty is overcome.

The results are astonishing. Fifty-six trucks per day, or at the rate of eight for every man, including the foreman, or charge-hand, is doing a good day's work, and the men are not in an exhausted condition by any means when the whistle blows. It is the result of carefully planned and specialized work. It also requires the prompt delivery of material and that it be arranged and piled properly. It is the foreman's or charge-hand's duty to watch the delivery of material and oversee and assist the men.

The accompanying photographs, showing the truck in different stages of erection, will assist in making the work of this department clear.

The wheels, after they are mounted, are placed on the track upon which the trucks are erected, as shown in Fig. 39. The journal boxes are fitted with dust guards and are placed on the journals by a helper, who devotes only a small portion of his time to this work. The journal boxes are stored in a large quantity alongside the track and additional storage room is provided just outside of the shop.

When the wheels in this condition are moved forward to a certain point two of the truck gang come back and fit the journal brasses and wedges in place. The wheels are then moved forward and the lower arch bar is placed on the boxes and the two column castings are placed on the sloping part of the bar. The sand plank (the brake hanger brackets are riveted to the sand plank in the smith shop) is then swung into place with a crane and the short bolts which connect it to the column castings are put in

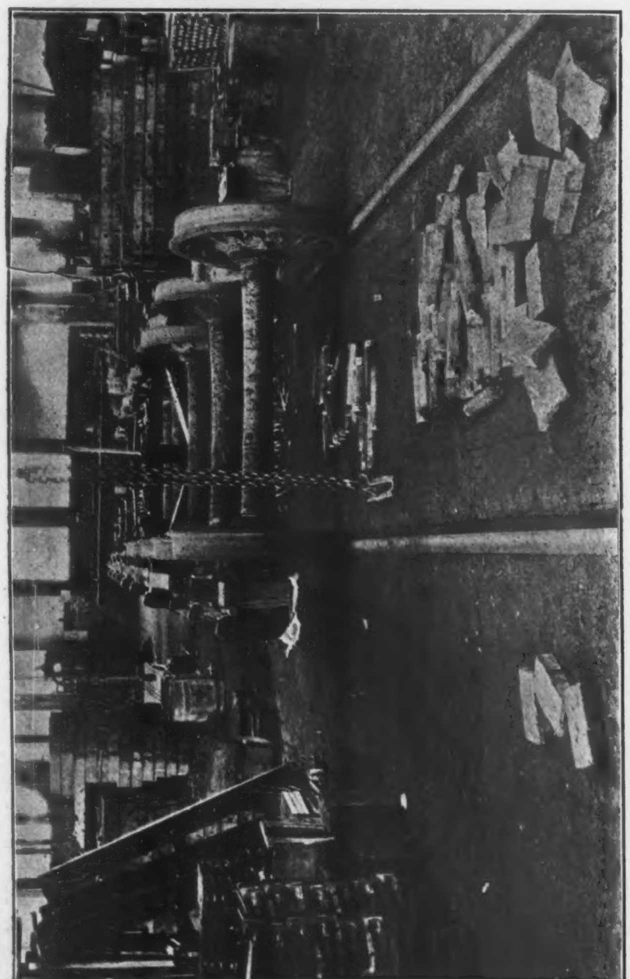


FIG. 41.—TRUCK ERECTING TRACK, SHOWING TRUCKS IN DIFFERENT STAGES OF ERECTION—ALSO ARRANGEMENT OF MATERIAL ALONGSIDE AND IN THE MIDDLE OF THE TRACK.

FIG. 42.—AN ADVANCED STAGE OF ERECTION.

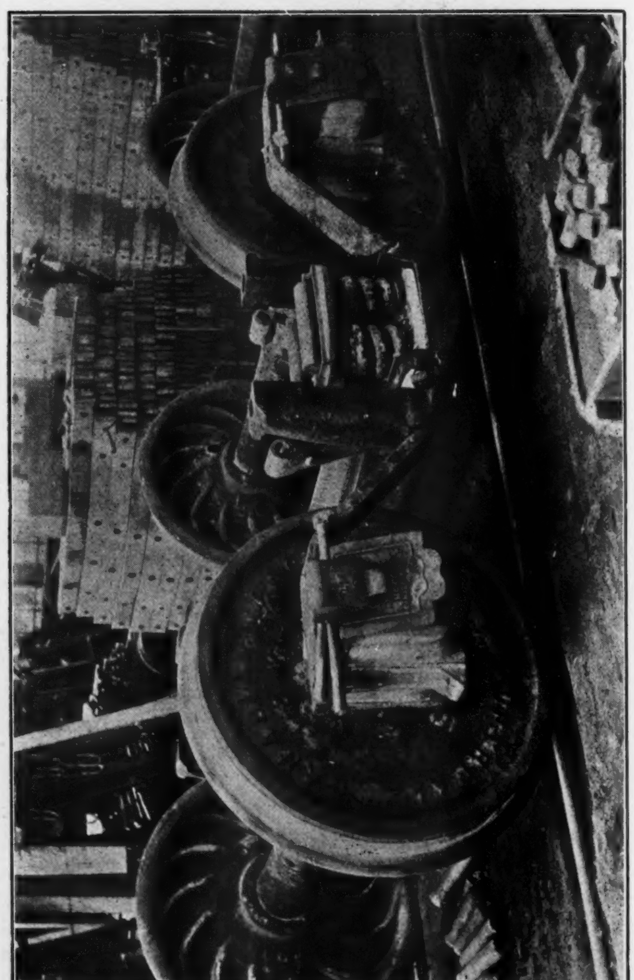


FIG. 40.—ONE OF THE EARLY STAGES OF ERECTION.

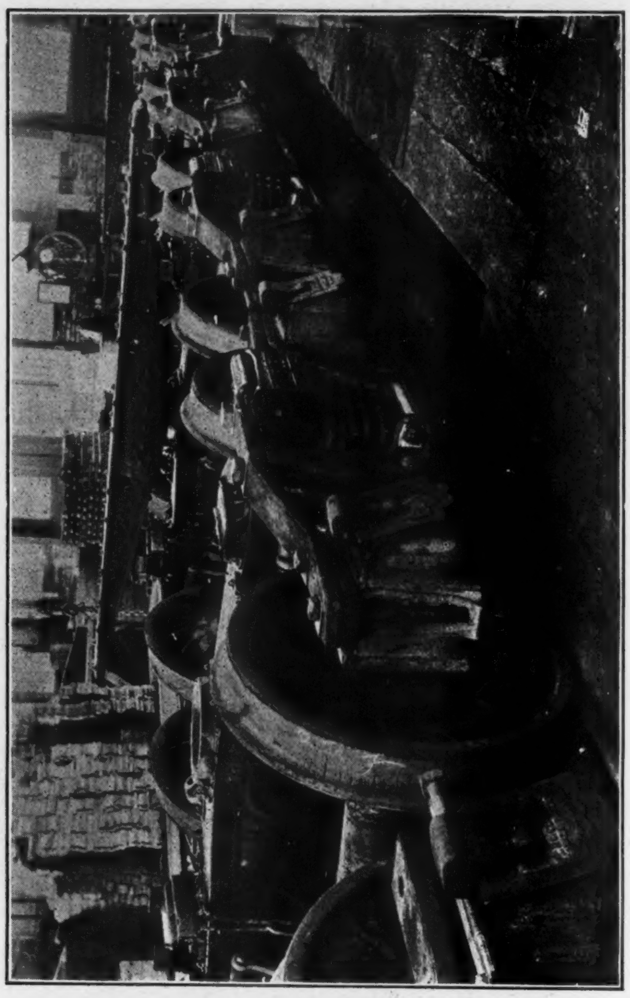


FIG. 43.—READY FOR THE TIE BARS AND THE FINISHING TOUCHES.

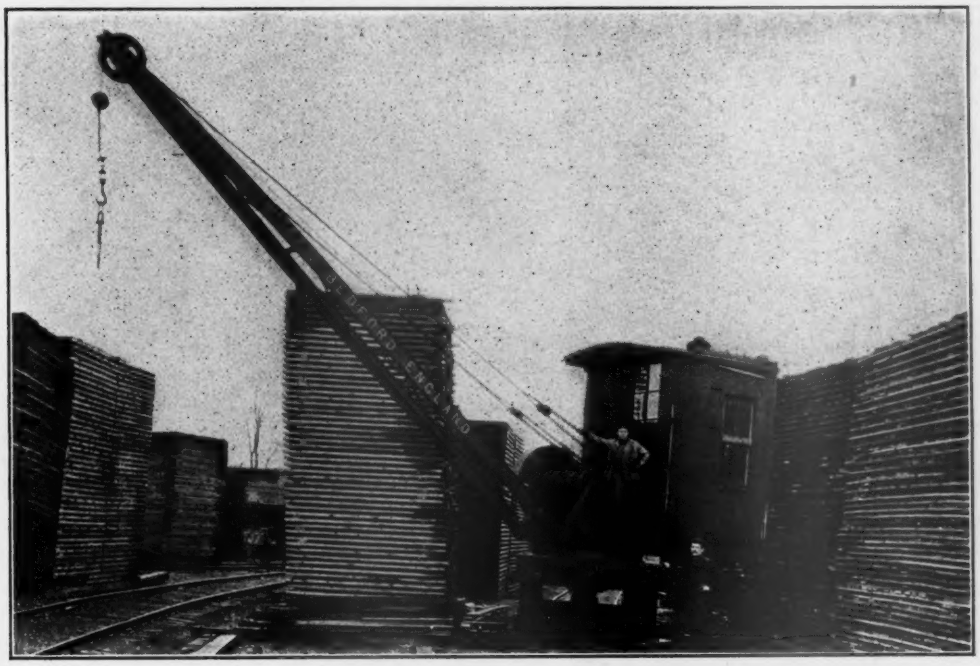


FIG. 45.—FIVE TON GRAFTON CRANE IN THE LUMBER YARD.

place, but the nuts are not drawn up tight. The spring seat, springs, spring cap and the Barber rollers, are put in place and the journal bolts are laid on top of the box alongside the arch bar. The truck in this condition is shown in Fig. 40. Another view of the same stage, but looking down the shop and showing the various stages of erection and the material piled along both sides and in the middle of the track, is shown in Fig. 41.

The truck is moved forward and the truck bolster is dropped into place by a crane and the top arch bars are placed in position. The column bolts are then driven in. The work described thus far, excepting for the placing in position of the truck bolster, has all been done by two men. The partially erected truck has been moved forward possibly a couple of times. While the first two men have been driving in the column bolts a third man has been engaged in hanging the brake beams. This man also tightens up the inside bolts which connect the column castings and the spring plank. When the work has progressed thus far the truck is again moved forward and two other men drive in the journal box bolts, while the sixth man is engaged in putting in the brake levers. This sixth man is the one who puts the truck bolsters in place with the aid of a crane and he also puts the body bolster in place after the truck has been completed. It is the duty of the fourth and fifth men to put the bottom tie bar into place and to put the nuts on and draw up the column and journal box bolts. As may be seen in Fig. 43, a pit is provided alongside the track for this last operation, so that the men may perform it conveniently.

One can hardly realize the rapidity with which a truck is erected without actually seeing it done. In watching the gang it was noticed that there was practically no talking among the men and questioning developed these facts. The gang boss was a Scotch-Irishman, who could talk no French; two of the men were Jews; two were French, one of them could not talk English; one was a Russian and could speak only his own language; the other member was an Italian and could speak English and some French. As the men were working piece-work it is not surprising that there was not much talking, but the fact that such a mixture of men could do such efficient work speaks well for the system of organization and of specialization. After the trucks are completed they are either pushed out of the shop and stored on the other side of the midway or are taken directly to the freight car building shop.

The Simplex truck and body bolsters, the springs, brake beams and journal boxes are unloaded from the cars and stored just outside the shop. The bolsters are unloaded by the 2,000-lb. Garry crane illustrated in Fig. 44. The end of the cable is fastened to the bolster inside the car, a piece of wood being placed between the cable and the side or top of the door, so that in drawing out the bolster the car will not be injured. These cranes were furnished by the Garry Iron & Steel Company, who have since disposed of this part of their business to the Cleveland City Forge & Iron Company of Cleveland. Clamps are provided for holding the crane to the rail when in operation. The revolving bed rests on a row of 196 1½ in. steel balls. The load is lifted by the air cylinder, and revolved by another air cylinder, placed within the revolving bed. The swinging movement is controlled by an air brake. The crane is portable but not self-propelling. It has a lift of 12 ft. 6 in. and a reach of 12 ft.

Lumber Yard.

The lumber yard covers about 40 acres and is laid out with 25 tracks. The store department inspects, culls and tallys all lumber as it is received, and sees that it is properly piled. An idea of the extent of this work may be gained from the following extract taken from a paper presented by Mr. J. H. Callaghan, the general storekeeper, before the Canadian Railway Club in January, 1906. The figures are, of course, still larger at the present time.

"For the ten months ending October 31, 1905, there were no less than 2,350 cars of lumber unloaded and piled, a total of 28,188,000 feet, or an average of 113,000 feet daily. The quantity delivered to shops and shipped on the line for the same period amounted to about 4,000,000 feet in excess of these figures. The stock carried for all purposes during the present year has varied from eight to thirteen million feet, board measure, of which quantity one and a half millions are carried for the purpose of supplying outside points and repair work, the balance for new equipment orders. The woods carried in this stock range from the ordinary spruce, pine, birch, and oak used for freight car construction, to the rarest imported woods used in finishing the passenger rolling stock."

The lumber is delivered to the planing mill and dry-kiln on four-wheel lorry trucks. The sills are loaded by the Grafton & Co. (Bedford, England,) 5-ton crane, shown in Fig. 45. When four or five of the lorry cars have been loaded they are coupled together and pulled to their destination by the Grafton crane. This crane is capable of lifting 5 tons at 15 ft., 3 tons at 21 ft., and 2 tons at 27 ft. radius, traveling with any of these loads when free and in any position. It has the following motions: Hoisting, lowering, either by the engines or by brake; slewing in either direction, independent of the sense of rotation of the engines; derricking and traveling. The driver at all times has a clear and

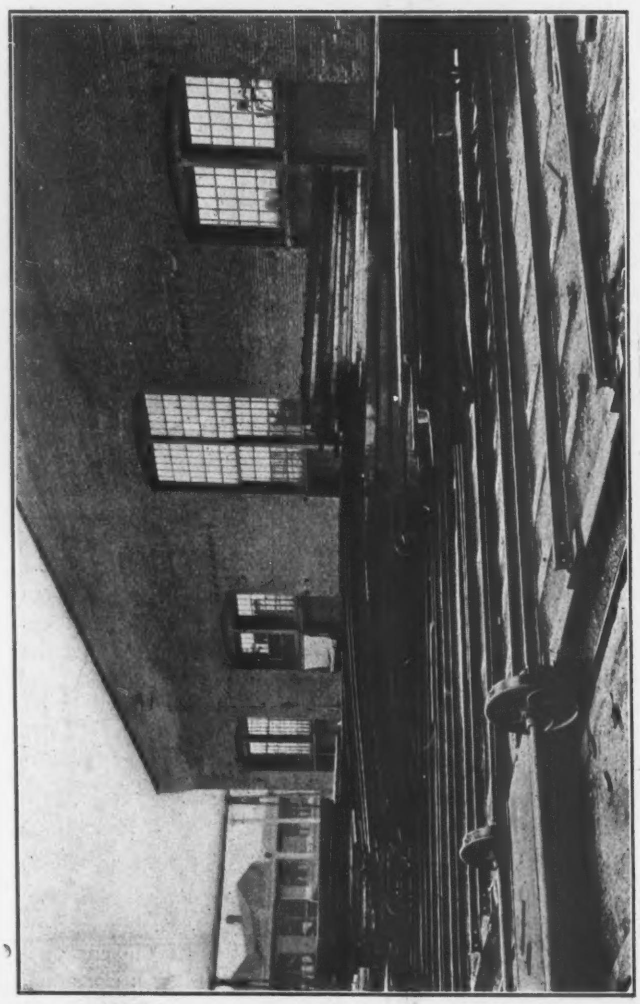


FIG. 46.—LORRY CARS LOADED WITH LUMBER READY TO BE TAKEN INTO THE PLANING MILL.

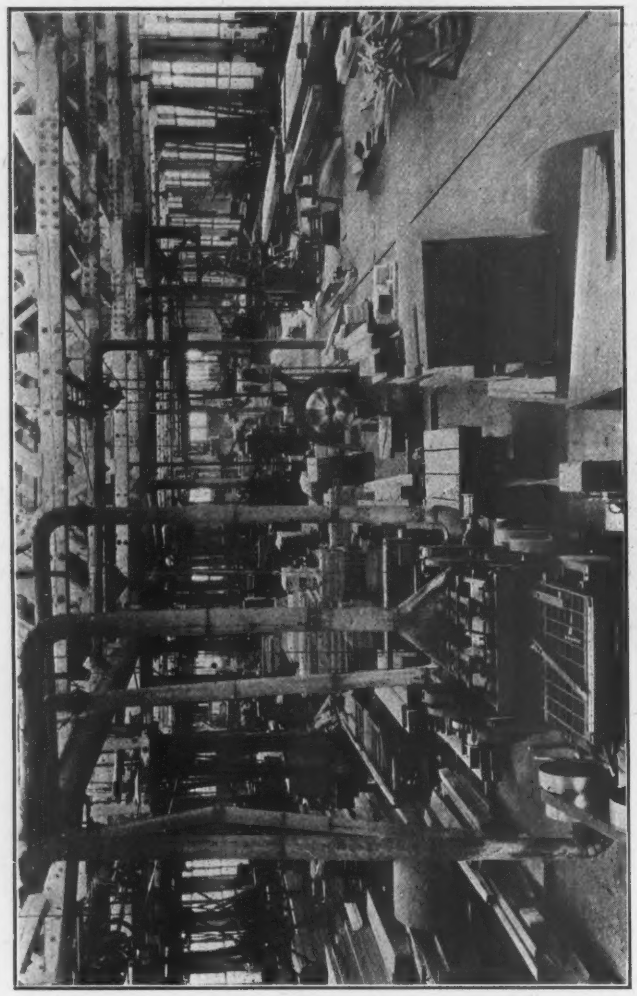


FIG. 51.—LOOKING DOWN THE MIDDLE OF THE PLANING MILL FROM A STAIRWAY AT THE EAST END.

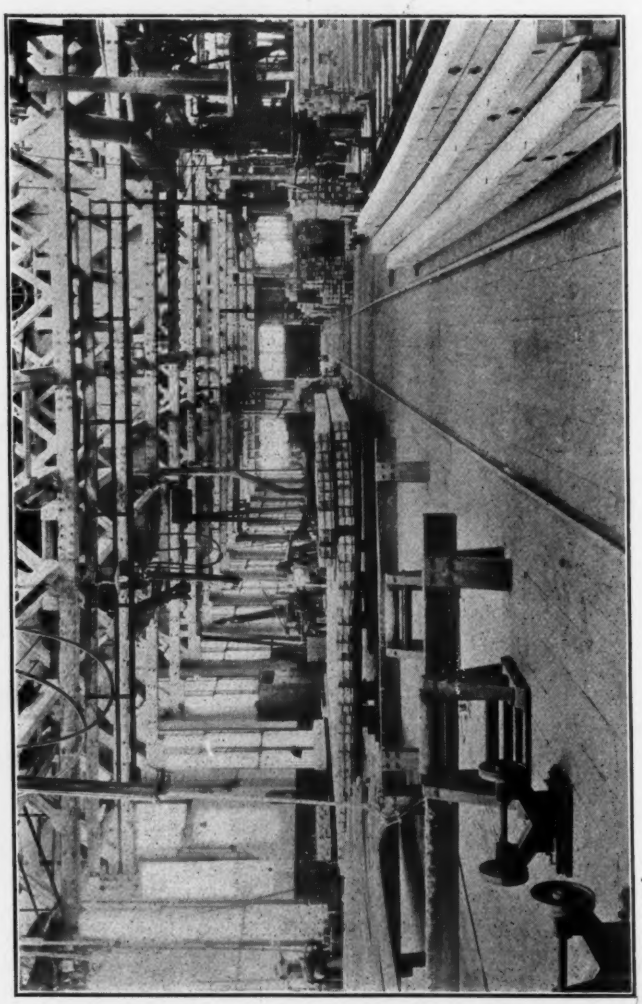


FIG. 50.—THE FINISHED SILLS READY TO BE TRANSFERRED TO THE FREIGHT CAR SHOP.

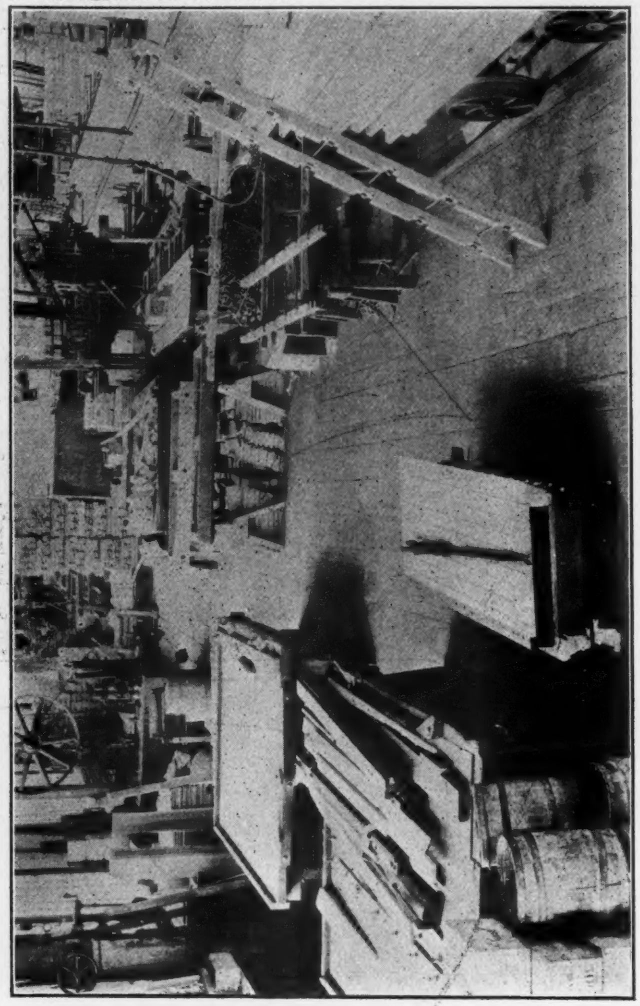


FIG. 52.—BOX CAR SIDE DOOR AND LADDER DEPARTMENT IN THE PLANING MILL.

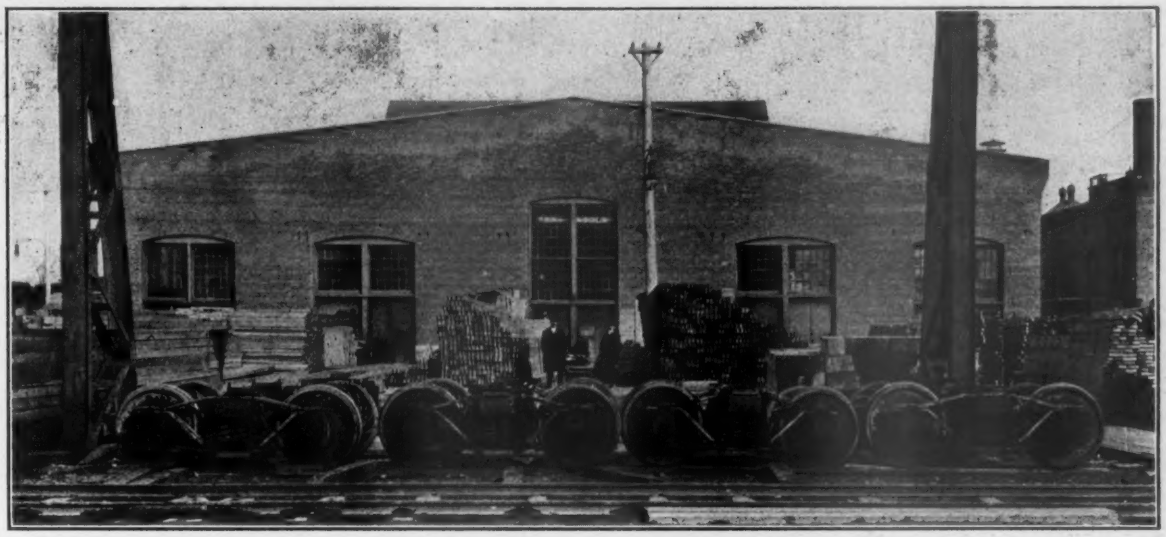


FIG. 48.—END OF THE PLANING MILL, LOOKING FROM THE FREIGHT CAR SHOP.

uninterrupted view of his work. A safe load indicator shows the radius of the jib and the corresponding safe working load.

Ordinarily the crane pulls about 4 or 5 loads, but the writer saw it handling 7 loads as follows: Three cars of sills (90); 2 cars end plates (100); 1 car needle beams (50); and 1 car purlins (120). These were taken to the north end of the planing mill (Fig. 46), and by means of the transfer table were placed where they could be run into the shop when needed.

Dry Kiln.

The dry kiln of the freight car department (Fig. 47) is located near the west end of the planing mill, is divided into three compartments, each 19 x 85 ft. and has a capacity for 148,000 ft. of lumber. The kiln is equipped with the Morton system, furnished by the A. H. Andrews Company of Chicago. The side walls are of brick, the division walls of timber and the roof is of wood with gravel covering. The ends of the kiln are covered with canvas curtains which may be rolled up. Special attention is directed to the location of the kiln. The machines in the mill, for finishing the lumber which passes through the kiln, are all located near the entrance from the kiln.

Planing Mill.*

The planing mill is directly across the midway from the freight car erecting shop, with sufficient space between it and the midway to provide for the temporary storage of finished material. This end of the mill is shown in Fig. 48. There is a transfer table, shown also in Fig. 1, just behind the trucks in the foreground of this view. For lack of space a plan of the mill is not reproduced. The one on page 117 of the April, 1905, issue is practically correct, as comparatively few changes have been made since that time.

The mill is divided into two parts with two foremen, one representing the freight car department and the other the passenger car department. It has two longitudinal tracks extending through it, dividing it into three parts. The part on the north side and the greater portion of the middle part are used by the freight car department. The sills enter at the northeastern end of the mill and are passed directly from the truck to the planer. A view looking down this part of the shop is shown in Fig. 49. The cross-cut saw at the right is used for cutting the sills to length. They are then laid off for drilling and tenoning and are passed down the shop to the end tenoning machine, five spindle vertical boring machine and gaining machine. Fig. 50 is a view looking toward the northeast from the point where the sills are in a finished condition and ready to be loaded on a truck with the air hoist and be pushed through to the freight car shop. The middle portion of the mill at the east end is used principally for finishing the various parts of the freight car framing and Fig. 51 is a view looking down this part of the shop from a stairway at the east end.

Just west of that part of the north side of shop, where the sills are finished, is a small department for building grain doors and side and end ladders, as shown in Fig. 52. A government regulation requires the addition of duplicate ladders and steps to all the freight car equipment in use. Twenty thousand of these ladders were built during the past year. They are painted by dipping them in a vat just west of the mill.

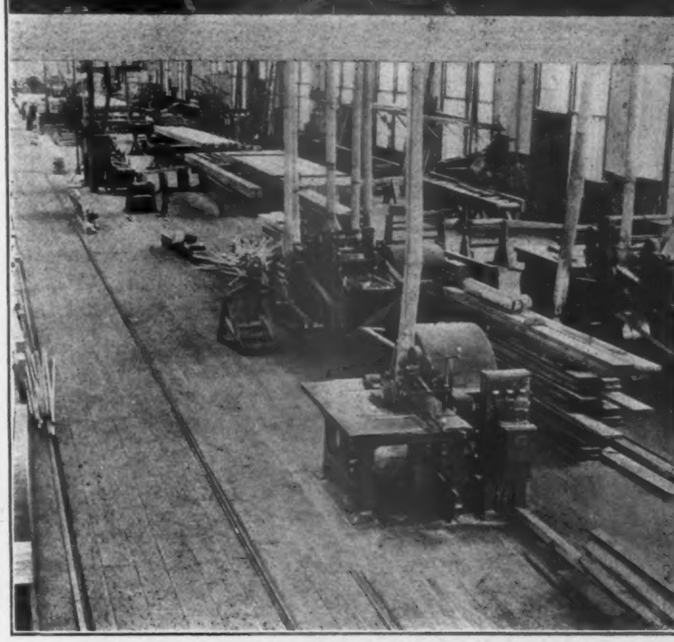


FIG. 47.—FREIGHT CAR DEPARTMENT DRY KILN.
FIG. 49.—SILL DEPARTMENT OF THE PLANING MILL.

* For a description of the building see page 37 of the February, 1905, issue.

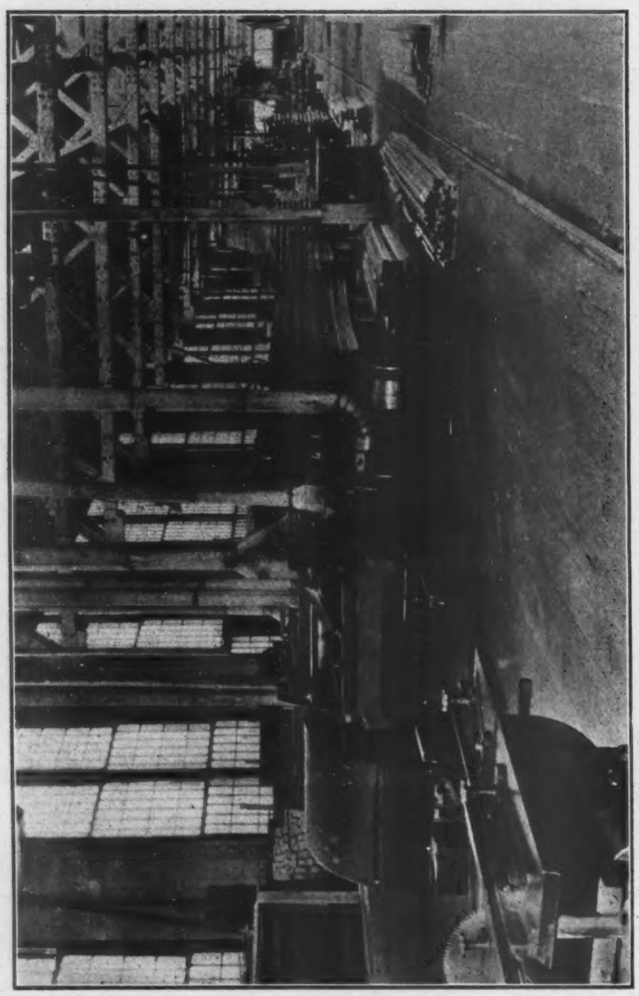


FIG. 53.—BERLIN PLANER AND CUT-OFF SAW AT WEST END OF MILL.

FIG. 54.—BOLT BINS AT EAST END OF FREIGHT CAR SHOP.

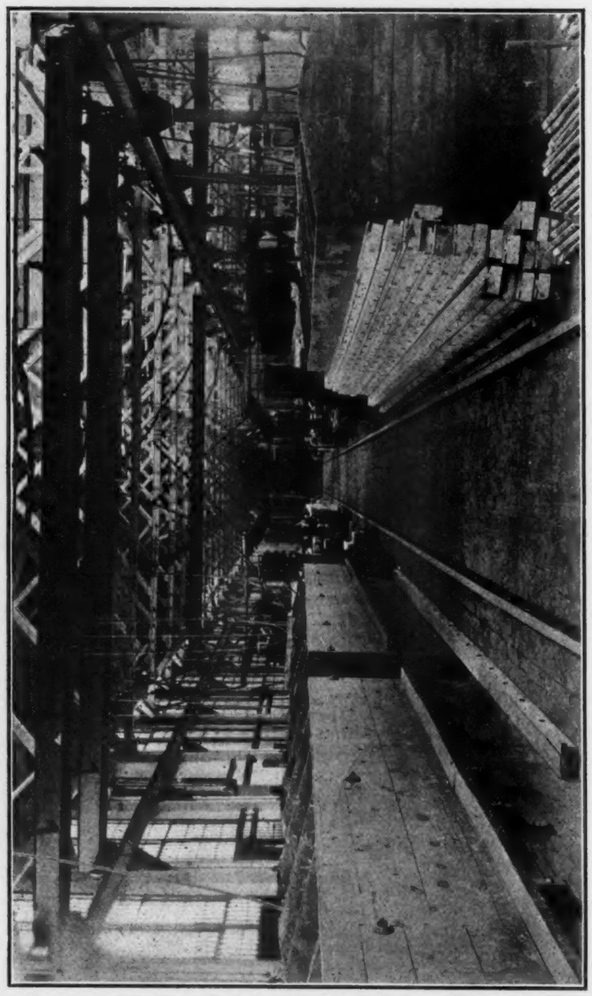


FIG. 55.—LOOKING DOWN ONE OF THE MATERIAL TRACKS.

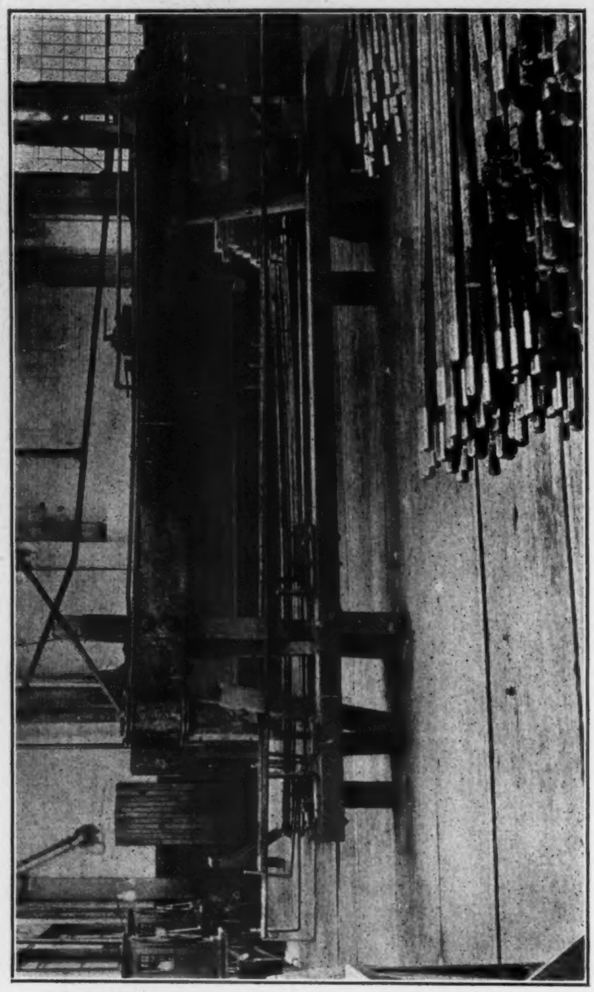
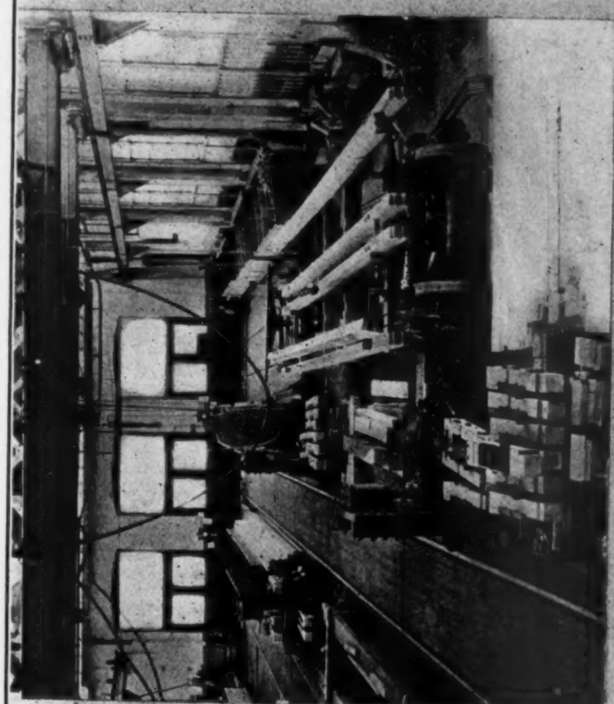
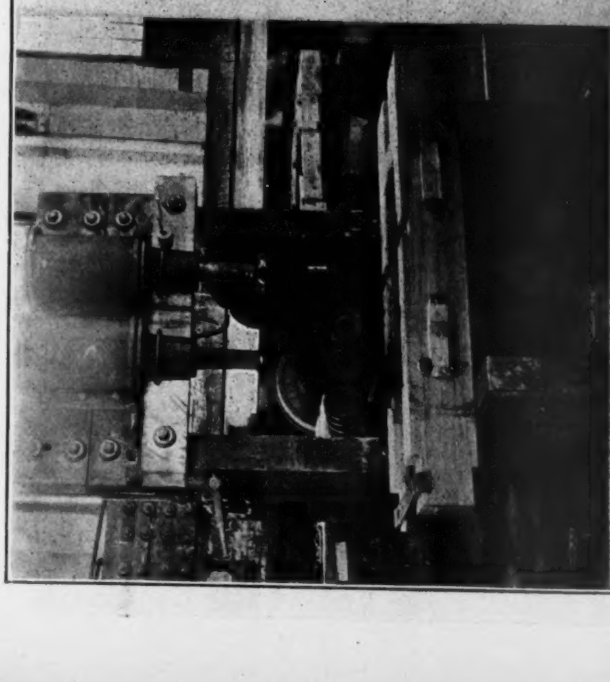


FIG. 56.—DEVICE FOR BENDING TRUSS ROADS COMPLETE AT ONE OPERATION.





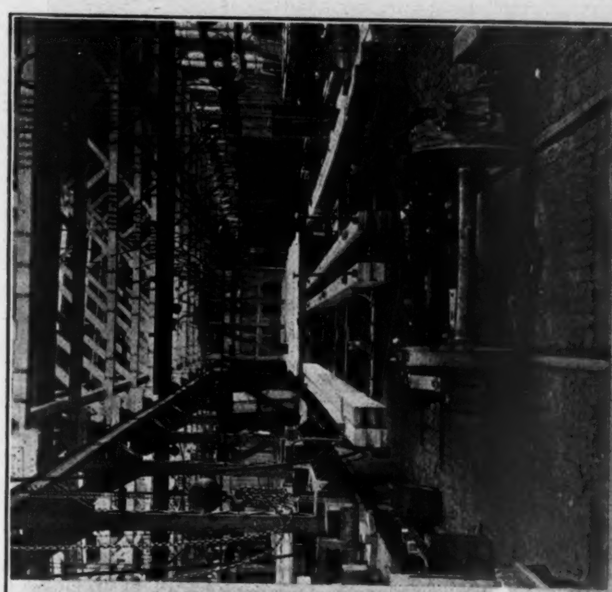


FIG. 57.—A CAR IN THE SECOND STAGE OF ERECTION. DRAFT RIGGING ASSEMBLING DEVICES SHOWN ALONGSIDE THE CAR AT EACH END. BOLT BINS IN THE REAR. FIG. 58.—DEVICE FOR PUTTING SPRINGS AND FOLLOWERS IN DRAFT SILLS. FIG. 59.—LOOKING DOWN ONE OF THE ERECTING TRACKS. A CAR IN THE SECOND STAGE OF ERECTION IN THE FOREGROUND. FIG. 60.—THE THIRD STAGE—LAYING THE FLOOR. FIG. 61.—THE FOURTH STAGE—THE ROOF FRAME WILL NEXT BE BUILT.

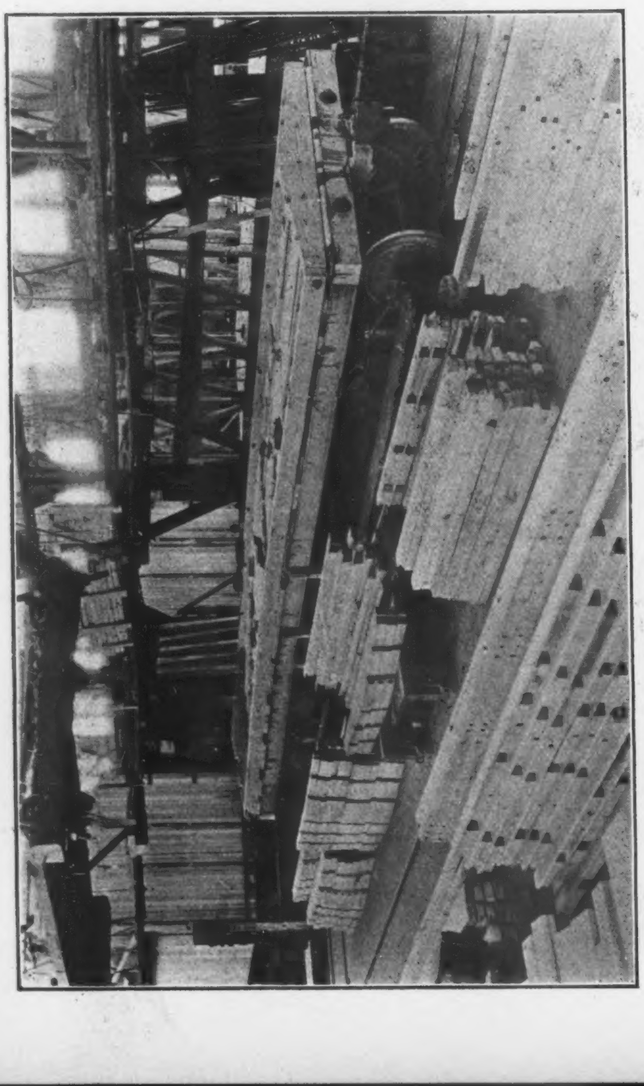


FIG. 62.—FOURTH STAGE—THE ROOF FRAME IS IN PROCESS OF BUILDING.

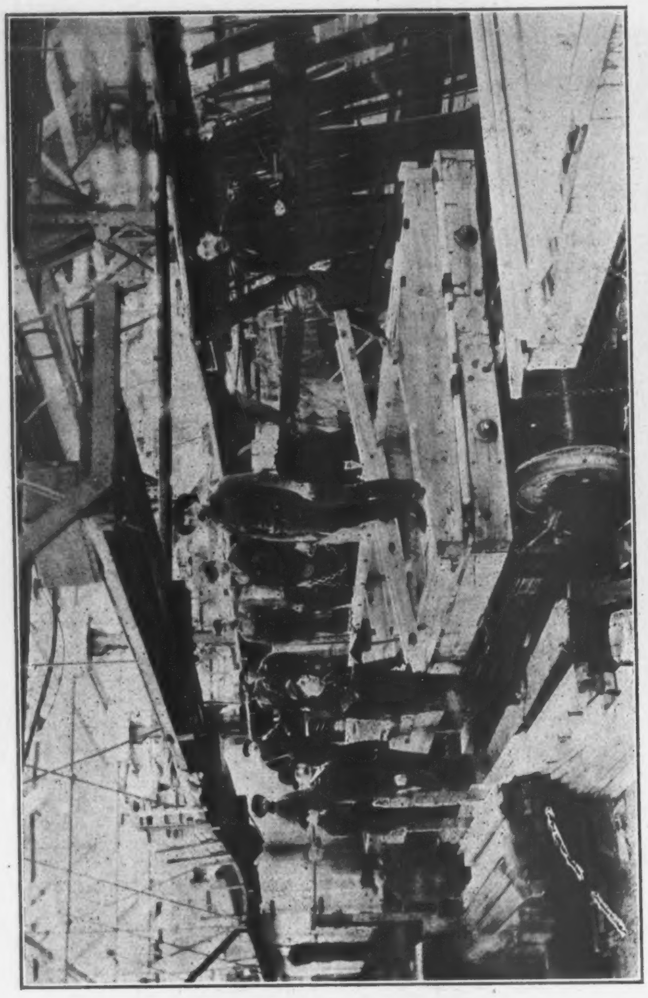


FIG. 63.—FOURTH STAGE—THE ROOF FRAME IS ABOUT TO BE RAISED.

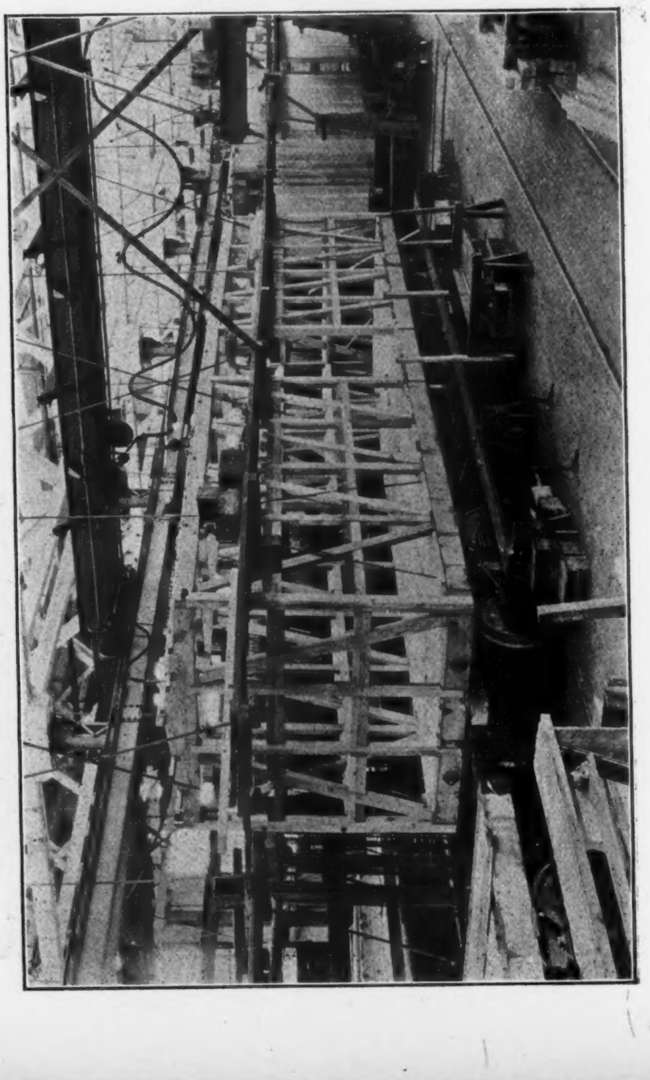


FIG. 65.—THE FOURTH STAGE COMPLETED.

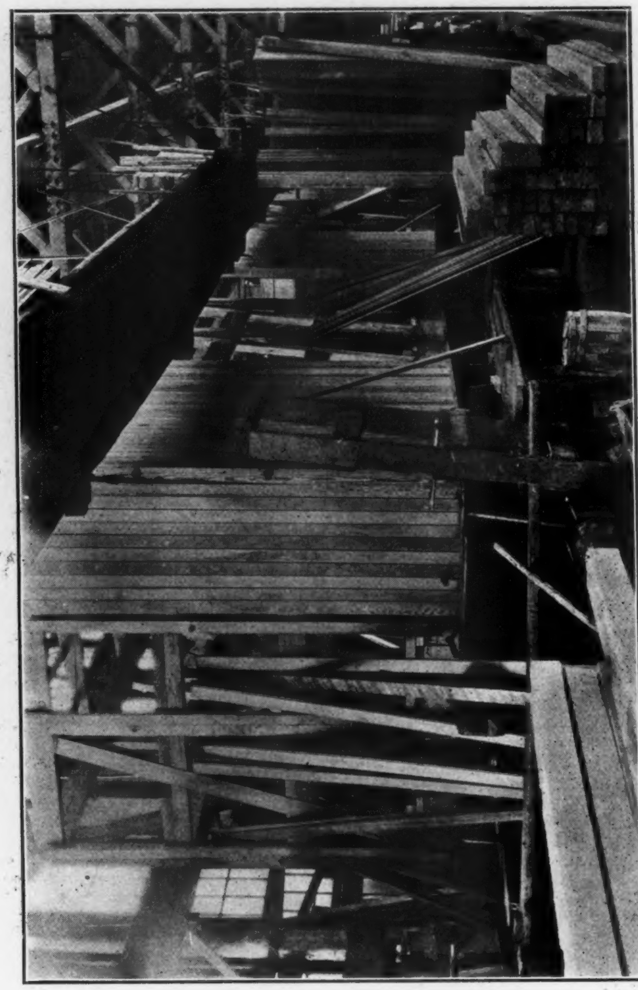


FIG. 66.—THE FIFTH STAGE—PUTTING ON THE SIDING.

The west end of the shop, near the dry kiln, is used for finishing sheathing, roofing and flooring as it comes from the dry kiln. The pieces are planed, cut to length and passed through holes in the doors or wall and loaded on trucks and taken to the freight car shop or temporarily piled just outside the mill. A view of one of the planers and a cut-off saw is shown in Fig. 53. The track which extends across the shop from the entrance nearest the dry kiln may be seen where it crosses the longitudinal track.

Freight Car Shop.*

The freight car shop is the most interesting part of the plant. The same general features which were emphasized in connection with the building of the trucks are true of the erecting of the car bodies, except that they are applied on a much larger and more important scale. The trucks with the body bolsters set on them are brought in at one end of the shop and the work of erecting the car body is divided into several stages. A certain number of men are detailed for each stage of the work. When the gangs have completed their tasks (and the work is so divided that they get through at about the same time) the cars in the various stages of erection are coupled together by spacing rods, 10 ft. long, and all are pulled forward one length by an electric haul. While the cars are being pulled ahead the men usually work right along and the efficiency of each man and the gang as a whole is thereby considerably increased. The use of the electric haul practically increased the shop output four cars per day. This method of erecting the cars incidentally greatly simplifies the handling of material. The same kind of material is delivered to the same place alongside the erecting track, by the laboring gangs, each time, and if they do get confused as to its location the workmen are not slow to correct them. Walking down through the shop the cars may be seen in the various stages of erection.

The stages in general are as follows: First the trucks are brought in at the end of the shop, the truss rod posts are bolted to the bolsters, the centre pin is applied, and bolts for attaching the centre sills are laid in place. Second, the underframe is erected. Third, the flooring is laid. Fourth, the body framing is erected. Fifth, the siding and inside end sheathing are applied and the galvanized iron roof is laid. Sixth, the inside of the car is finished, the outside trimmings are put in place, the roof is finished and the brakes are applied. Seventh, the running board is laid.

There are six longitudinal tracks in the building, two for material and four for erecting purposes. In all about 200 men are employed on actual erecting work, divided into four gangs of 50 men each. Each erecting track is overlooked by a gang foreman.

Possibly the best way of presenting a clear idea of this work would be to consider the various operations of building the car in more or less detail.

First Stage.—The trucks are brought into the end of the shop and one of the men in the gang engaged upon the second stage slips back, as he can find time, and bolts the truss rod posts on the top of the body bolster, puts in the centre pin and lays the sill bolts on top of the bolster.

The bolts are stored near the entrance of the shop in bins, shown in Figs. 54 and 55. They are delivered from the machine shop on lorry trucks in the boxes (see Figs. 27, 29 and 36). These boxes hold 600 or 700 lbs. of bolts and six of them are loaded on each truck. One man has charge of seeing that they are properly distributed in the freight car shop. The boxes are lifted by an air hoist which operates on a U-shaped track, with the legs of the U extending over the bins on each side of the track. When the box is over the proper bin a hook from a chain which is suspended from above the hoist, is fastened in an eye in the bottom of the box. As the hoist is lowered the box is gradually tipped and emptied into the bin. When the bins are full the workmen can easily reach the bolts, standing on the floor. A step has been attached to the side of the bins, as shown, to facilitate reaching the bolts when they are only partially full.

Fig. 55 is a view looking down one of the material tracks, showing the bolt bins on either side and the three 2,000-lb. Whiting cranes extending over two erecting tracks and the material track. These traveling cranes are equipped with air hoists. The two nearer ones are used principally for hoisting the sills into place, and the third one is used for hoisting the roof frame; its length of travel is restricted, as is noted later.

A simple device for bending a truss rod complete in one operation is shown in Fig. 56. It consists of a frame work with two air cylinders and the necessary guides and stops for properly shaping the rod. The handle for operating the device is shown above the top member of the frame, at about the middle. A duplicate set of cylinders, etc., are attached to the other side of the framework for bending the rods for use on the far side of the shop. The different cars in the various stages of erection, when they are ready to be moved, are connected together by spacing rods, and by means of a motor driven winch are pulled forward the proper distance.

Second Stage.—The two trucks are moved forward and the men in the first gang start to work on the underframe. Two men place the center sub-sills, which fit between the needle beams and bolster, with the bolster ends resting on the inner truck axles. The needle beams are placed near the ends of these sills. Meanwhile two of the men have swung the side sills into place with the aid of a crane. A fifth man has been engaged in fitting the draft rigging together with the device shown in Figs. 57 and 58. This consists of a simple framework with two air cylinders mounted upon it. The cheek plates are first bolted to the sills, and after the sills have been bolted together the springs and draft lugs are forced in place by the air cylinders. The two men working on the side sills put the corner post pockets in place and the two men underneath the car put up the needle beams. The center sills are then put in place. The intermediate sills are placed and bolted. A car at about this stage of construction is shown in Figs. 57 and 59. The former shows the arrangement of the bolt bins, and also the location of the draft rigging assembling devices, one being placed at each end of each car. Fig. 59 shows cars in the second, third and fourth stages of erection. The queen posts are next placed on the needle beams. By this time the draft rigging has been assembled and is swung into place with a crane and bolted by the vertical bolts through the sills. The two men underneath the car put up the brake cylinder. The truss rods are put in place and the end sills erected. Red preservative paint is put on the tops of the sills; turn buckles are applied to the truss rods. Pocket castings are placed on top of the sills for the frame posts. Meanwhile one of the men has found time to go back and put the truss rod posts on the two body bolsters on the trucks at the rear, which the laboring gang have brought into the shop. The underframe is complete when it leaves this gang, except that the truss rods are not drawn up and the dead woods are not applied.

Third Stage.—When the car is pulled forward a gang of four men lay the flooring. Usually they find time to go back and put some of the flooring on the frame before the car has been moved forward. Two of the men fit the flooring, starting from the middle of the car, boring it where necessary because of projecting bolt heads, or cutting it out with an axe where it has to be fitted over large washers. It is also necessary to cut the flooring to fit between the post castings. The two men who are nailing start most of the nails and then drive them home with a heavy hammer. While the two men are doing the heavy nailing the two fitters are arranging the floor timbers at the ends. The car shown in Fig. 60 is in about this stage of construction. The belt rails which are to be used in the next stage of construction are shown in the foreground where they can readily be piled on when the floor is finished and be ready for the next stage (see Fig. 61). The final operation is to lay off the deck boards and cut them to the proper length at the side door. The men who finish first start to get the material ready for the next car.

Fourth Stage.—The men first arrange the side posts and belt rails, etc., on the floor of the car, as shown in Fig. 61. This material is carefully placed so that when the roof frame is raised it may be assembled quickly. The belt rails, which are shown more in detail in Fig. 64, are either made from one piece on a special machine in the planing mill, or are built up from a num-

* The building was described on page 4 of the January, 1905, issue.

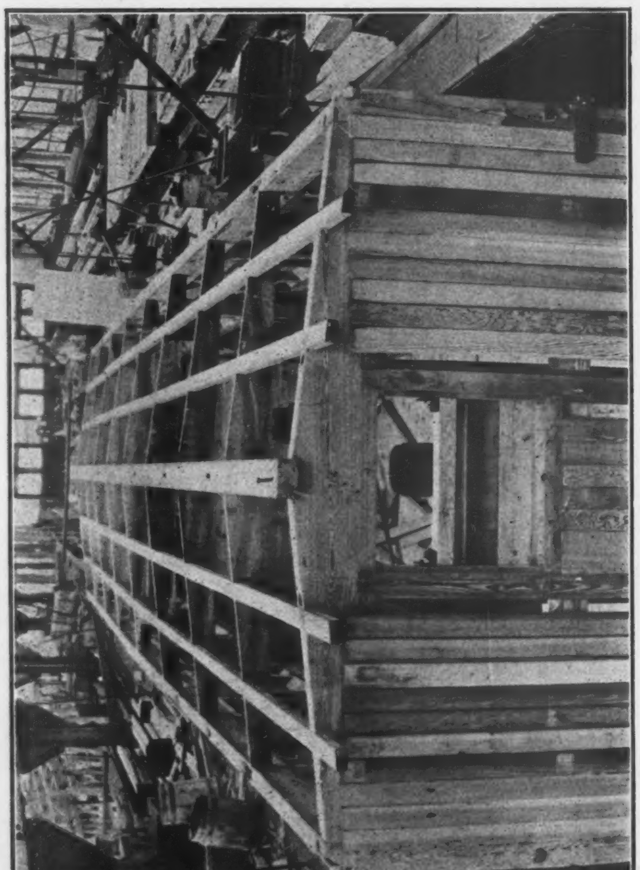


FIG. 67.—A VIEW DURING THE FIFTH STAGE.

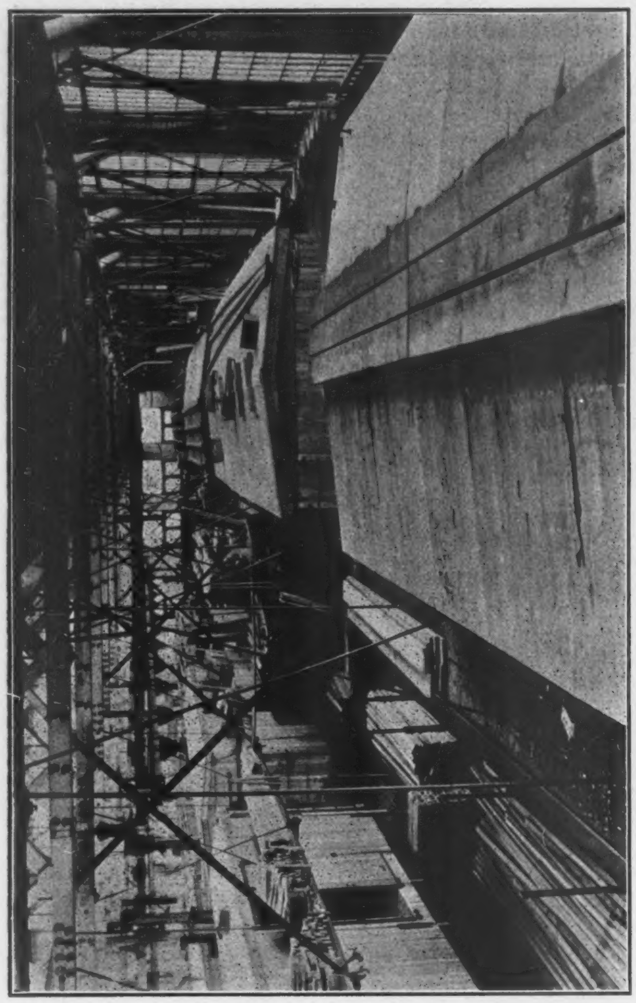


FIG. 68.—SHOWING ROOFS IN THE FOURTH, FIFTH, SIXTH AND SEVENTH STAGES OF CONSTRUCTION

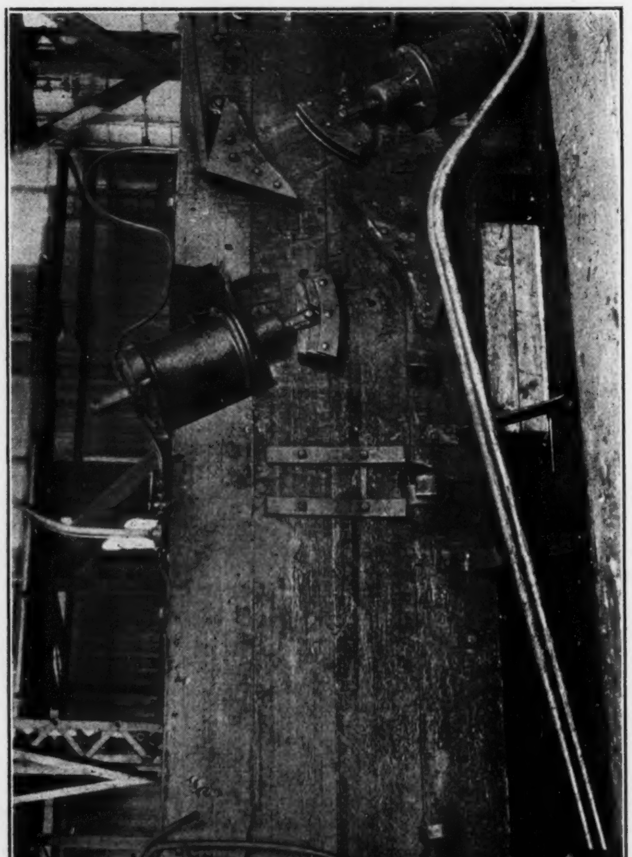


FIG. 69.—PNEUMATIC DEVICE FOR BENDING BRAKE PIPES COMPLETE IN ONE OPERATION.

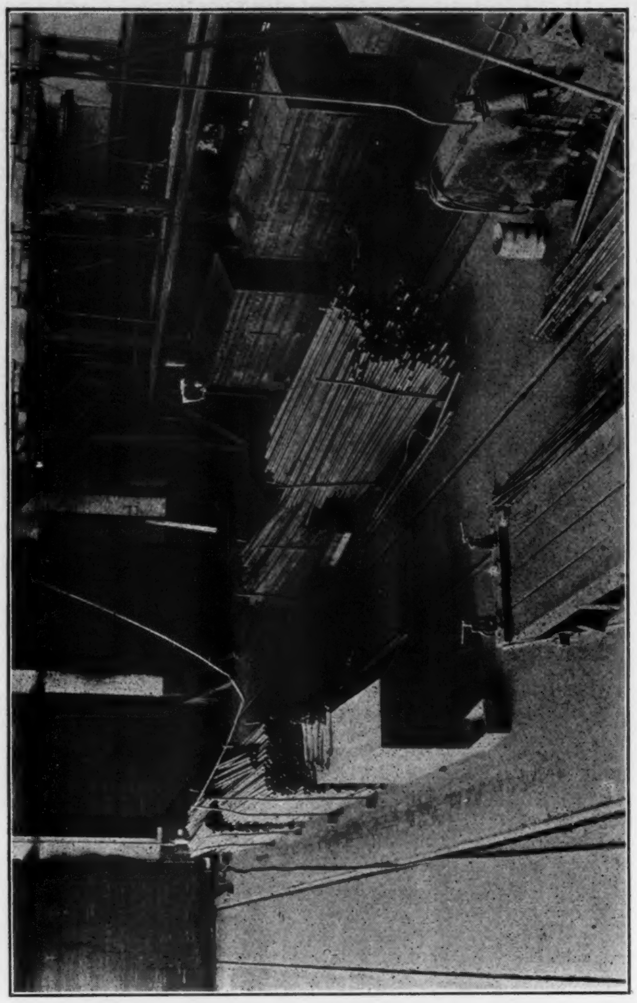


FIG. 70.—LOOKING FROM THE TOP OF A FINISHED CAR TOWARD THE PAINT SHOP.

ber of pieces, as shown in the illustration. This work is done by one of the men in the body frame gang in the erecting shop. The small pieces are made from short lengths which cannot be used for other purposes. They are assembled to template.

The frame of the roof is built around and to receive these

FIG. 72.—SIDE VIEW OF THE PAINT AND FREIGHT CAR SHOPS. PAINT SHOP AT THE RIGHT.
FIG. 74.—ONE DAY'S OUTPUT.
FIG. 73.—THE FINISHED CAR, READY FOR WEIGHING.
FIG. 71.—STORAGE OF MATERIAL ALONG THE NORTH SIDE OF THE CAR SHOP.

parts (Figs. 62 and 63), and when it has been completed the long vertical rods are dropped through the holes in the framing and the roof frame is hoisted by a crane. This crane is used for this purpose only, and because of the rods which support the platform alongside the car, cannot be moved away from this place. While the roof is held suspended the side, corner and end posts are fitted into the castings on the underframe, the braces are fitted and when this is all arranged the roof framing is lowered over it and it is forced down into place with sledges; the belt rails are applied, and the various vertical and diagonal rods are tightened up (Fig. 65). There are ten men in this gang.

Fifth Stage.—The siding (Figs. 66 and 67) and inside end lining are put on and the galvanized iron roofing is laid. Twelve men are engaged upon this. It includes also the hanging of the side and end doors, the arranging of the corner bands inside and out, the application of the dead woods and the drawing up of the truss rods.

Sixth Stage.—This includes the finishing of the inside lining and the roof, except the running board. Also the application of the brake pipes and trimmings.

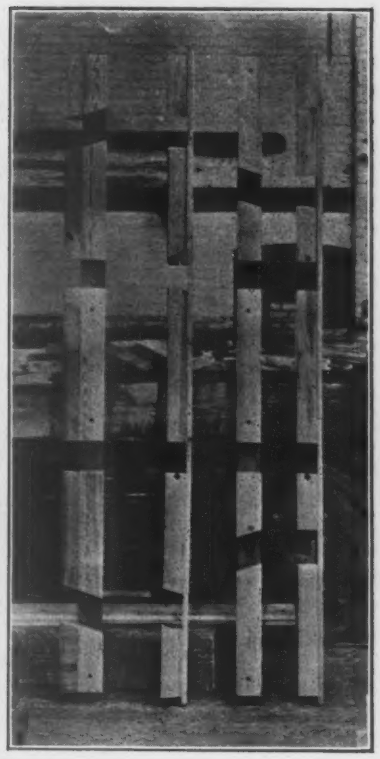


FIG. 64.—BELT RAILS.

Seventh Stage.—This includes the laying of the running boards, the application of the foundation brake gear, finishing the trimmings and the cleaning out of the car. The last four stages, as far as the roof construction is concerned, are clearly shown in Fig. 68. One man attends to packing the journal boxes for all four gangs.

At the end of the shop nearest the paint shop are several tools, including a grindstone, pipe cutters, and rip saw. Here also are kept the supplies of pipe for the brakes and the nuts, washers, nails and screws. A special pipe bending device is used, shown in Figs. 69 and 70. The pipe is bent complete in one operation. It is bent sidewise by a third air cylinder, the plunger of which is shown near the bottom of the frame at about the middle.

The bins containing the nails, screws, washers, nuts and nut

locks, are locked at the top and have openings at the bottom, as shown in Fig. 70, from which the material is removed. Seven hundred kegs of nails may be stored in these bins. The lumber when it is brought into the shop is piled in U-shaped cradles. It does not have to be piled as carefully in this way, thus saving more or less time.

As noted at the beginning of this article, 28 standard 60-ton box cars have been regularly turned out in a day of ten hours with a force of about 200 men, or fifty men to a gang. In addition one man mixes the oil and waste for packing; one man packs all the boxes; there are six men in the pipe gang; one man looks after the bolts, etc.; there are four sweepers or cleaners; thirteen men are required to bring in the timber, which approximates 125,000 ft. per day. The general foreman, Mr. Hailey, has two assistant foremen in this shop.

The castings, draft springs, metal roofing, etc., are stored outside the shop and the rods are stored in bins similar to those illustrated in Fig. 38. Some of the material, outside the north side of the shop, mostly roofing, is shown in Fig. 71. The workmen are required to bring in the castings and roofing material which they use.

Painting.

The sliding doors between the freight car shop and the paint shop are shown in Fig. 70. The cars are pulled into the paint shop by the motor driven winches which are also partly shown in this view. The paint shop is 321 ft. long and contains 6 longitudinal tracks.

The cars are painted with spraying machines which were developed at these shops. Six men are required for this work and six for stenciling. Two coats of paint are applied and the cars are usually completed by the second evening after their erection. One man gives all his time to mixing and issuing the paint. This is done in a small addition to the freight car shop, the packing being handled in the same place.

A side view of the paint shop building, also the freight car shop, is shown in Fig. 72.

Inspecting and Weighing.

One man, who reports directly to the general foreman of the freight car department, inspects the cars carefully and sees that they are turned out in first-class condition. The finished car is shown in Fig. 73. One day's output, ready to be pulled out and weighed on the scale, shown northeast of the paint shop on the general plan, is shown in Fig. 74.

We gratefully acknowledge indebtedness for information and courtesies to the officers and men of the car department.

Car Statistics.—Bulletin No. 14 of the American Railway Association, Committee on Car Efficiency gives some very interesting information concerning car performances for the month of August, 1907. While this information is given for each individual road a recapitulation for the whole country is included and shows conditions during that month to have produced the following results:

Total cars in service	2,060,066
Per cent. of home cars on line	62
Per cent. of cars in shop	6.21
Number of cars on line per freight locomotive owned	65
Average miles per car per day	24.1
Per cent. loaded mileage	70.8
Average tonnage	14.6
Average tonnage per loaded car	20.8
Average ton miles per car per day	351
Daily earnings per car owned	$2.52
Average earnings of cars on line per day	$2.44

To succeed is to study and when one quits studying his business he should at that time make up his mind that he attained his limit of success and the next change for him is a start on the "toboggan" just as sure as day follows night. This applies to the engineman who cannot be shown as well as to all others in the organization.—*Mr. D. R. MacBain before the Traveling Engineers' Association.*

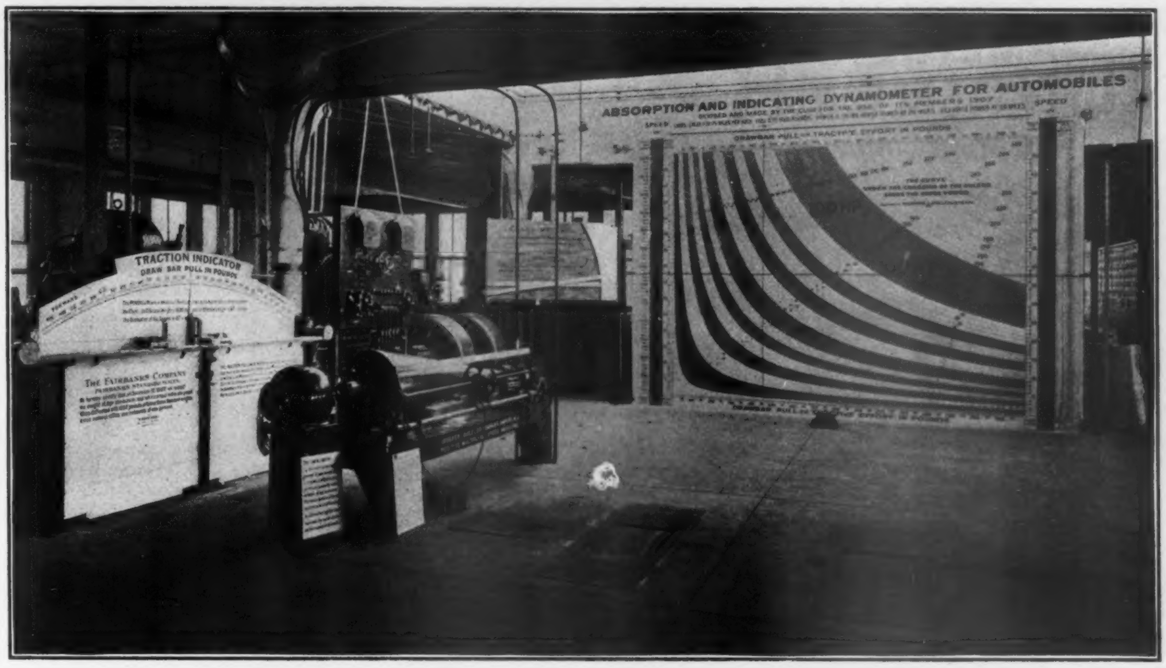
TESTING MACHINE FOR AUTOMOBILES.

There has recently been put into operation at the New York Club House of the Automobile Club of America a very interesting machine for accurately testing all of the more important features of automobile operation. This machine will accurately indicate the speed of a car, the tractive effort in pounds, the horse-power which is being delivered at the contact of the rear wheels, the grade in per cent. or feet which the car could climb at this speed, the inclination on which the brakes would hold the car, the internal friction of the car or engine and other similar information. The whole apparatus, which in principle is modeled somewhat after a locomotive testing plant, was designed by Dr. S. S. Wheeler, vice-president of the club and president of the Crocker-Wheeler Company. Many features of the absorbing and recording instruments are entirely original and most interesting.

The general features of the dynamometer are shown in the illustrations, and in brief consist of two large wheels, on which the driving wheels of the automobile rest, mounted on a shaft supported below the floor and having their upper edges projecting above the floor level. This shaft connects through a clutch to an Alden friction brake, which absorbs the power from the shaft by transferring it to the movement of a huge pendulum, which is seen hanging from the shaft at the left in the lower illustration. The movement of this pendulum from the vertical is an accurate indication of the amount of power absorbed by the friction brake and is recorded in pounds by a pointer on the scale shown on the extreme left in the upper illustration, this scale being laid off proportional to the sine of the angle at which the pendulum is swung from the vertical. The speed of cars is recorded directly from the dynamometer shaft, allowance being made for the difference in diameter of the wheels, by a very ingenuous instrument which will be described.

One of the most valuable features of this plant is the transferring of these speed and tractive effort readings to a large chart directly in front of the car being tested. This chart, as can be seen in the illustration, has vertical scales showing the speed in any desired unit and horizontal scales showing the tractive effort in pounds. The cross rulers, giving these indications, are operated by cables, whose movement is controlled by electric motors. These motors are operated through electric contact devices so as to closely follow the movement of the pointer showing the tractive effort and transfer the reading accurately to the large scale, and also from the speed meter to the large scale. This construction is so accurate that the slightest variation in either is instantly followed by change in position of the ruler on the large chart.

The transferring of the record of the speed to the cross ruler on the chart is accomplished by a special apparatus of considerable novelty. This is shown as located in the left foreground of the upper illustration and consists primarily of a cone which is revolved at absolutely constant speed by an electric motor. This speed is verified by a bell attached to the cone shaft, which rings at each 100 revolutions or at intervals of 30 seconds, since the cone revolves at 200 r.p.m. The speed of the dynamometer shaft is transferred by shafts and bevel gears to a shaft parallel to the surface of the cone. A wheel or roller is driven by a light frictional connection to this shaft, being so arranged that it has a free movement along the shaft and tends to revolve at the same speed. The circumference of the wheel, however, rests against the surface of the cone with sufficient pressure to cause it to revolve at the same speed as that particular part of the cone with which it is in contact. This causes a slipping in its connection to the shaft which brings electric contacts into action and starts a small motor. This motor by a cable connection pulls the wheel along the shaft until it finds a point on the cone which will cause it to revolve at the same speed as the shaft. When that condition is attained the motor controlling its movement is held idle, but any change in the speed which will permit a slip in either direction will again put the motor in operation and change the location of the roller to a new position on the cone. The horizontal movement of this wheel is transferred by the same cables to the horizontal ruler on the big chart.



GENERAL VIEW OF AUTOMOBILE DYNAMOMETER SHOWING LARGE CHART.

PENDULUM, FRICTION BRAKE AND APPARATUS BELOW THE FLOOR.

Since horse-power is a function of speed and tractive effort, both of which are shown on the chart, it was a comparatively simple matter to lay out curves showing the different horse-powers for all different conditions, which will permit the instant reading of the horse-power being delivered at the rear wheels by noting the point at which the two moving scales intersect.

The instrument showing the grade which could be climbed at the speed indicated is controlled by the same cables showing the tractive effort on the chart and consists of a pointer fulcrumed at one end and operated from the horizontal cross piece by a clamp which can be set at the proper weight for the car and its occupants. This scale is laid off proportionally to the sine of the angle of the grade, which equals the tractive effort in pounds divided by the weight of the car in pounds, both to the same scale.

A large motor is provided below the floor, which can be thrown on to the driving shaft by means of a clutch, and thus the amount of power required to drive the car with either the engine connected in, which would give the total internal resistance of the car, or thrown out, which would give the resistance for coasting, can be easily read from the chart, as can also the holding power of the brakes.

This dynamometer and all of the electrical apparatus used thereon was built by the Crocker-Wheeler Company.

CUSSING OF NO VALUE.—One thing to remember is that if a man does not know he cannot be cussed into knowing, especially if you have only a short time in which to give him the treatment. A better plan is to wait an opportunity, and not let it pass when it comes, to talk with the man in a quiet and deliberate manner and do your best to give him such help by way of instruction and advice, as will enable him to do better in the future. These are the correct lines to work along and if results cannot be obtained in such a manner better drop the man, as the cussing process sometimes results in embarrassment to the cusser.—*Mr. D. R. MacBain before the Traveling Engineers' Association.*

TIMBER RESOURCES OF OREGON.—It has been estimated that there is sufficient timber, at present standing in the State of Oregon, to build a solid board fence 50 ft. high around the entire United States.